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"Vision" and "War".

LORD RAYLEIGH'S presidential address to the British Association for the Advancement of Science, which was reproduced in *Current Science* for last month, consists of two parts. The first part is devoted to the consideration of the historical development of the auxiliary physical instruments invented by scientists for assisting their natural organs of visual perception for exploration of those phenomena in the material universe which happily lie beyond the faculty of their physiological mechanism of vision. The second part forms a brief but effective defence of scientists who are generally but unreasonably accused of being responsible for all the atrocities of modern wars.

We know that the extremely complicated and delicate human eye is the outcome of a long evolutionary process from some simple and generalised type, and that it is adapted to react to the bulk effects taking place in the environment. The sensory organs have therefore a survival value, for on their power and acuteness depends the individual and communal life. Nature never intended them to be used for the purpose of investigating the atomic structure or the passage and behaviour of electrons. The physical scientist has had to supplement the mechanism of the eye by devices which have supplied its natural deficiency, in a way essentially identical with direct scrutiny. The concept of the universe developed by the scientific worker, equipped with the most delicate and sensitive optical instruments, must necessarily differ from the standpoint of the man, who relies upon his unaided vision and intuition for the interpretation of the phenomenal world, and it is open to the philosopher, taking a general interest in the results of modern science, to conclude that science contradicts the evidence of the senses. The growing feeling for effecting a reconciliation of such apparently contradictory views, must have led Lord Rayleigh to give a historical review of the methods and results achieved by the physicist using the technical apparatus which his inventions have placed at his disposal. In dealing with the increasing employment of optical goods for the investigation of the behaviour of matter in all states, Lord Rayleigh has emphasised that in view of the fact that we have to depend mostly upon our visual perception for the greater part of our knowledge of nature, the means at the disposal of scientists

for improving their devices to carry forward their researches need not be considered as exhausted, and that extravagant optimism about their limitless extension, while theoretically admissible, is not justified having regard to the histologically circumscribed character of the sensory surface of the natural organs. The lenses, telescopes, microscopes, cathode rays, X-rays, spectroscopy, photo-electric surfaces and television certainly promise prospects of future developments, but they form only one gateway of knowledge to obtain world experience, which cannot be complete, because our sense perceptions are extraordinarily vague and confused modes of experience. Modern physical sciences are the product of a co-ordinated effort, carried on through centuries, to investigate those phenomena of nature which produce the transitions of sense perception or awareness, and science has no explanation to offer for the necessity of these phenomena, nor has science the power to endow its formulæ for the observed phenomena with any self-consistent meaning.

In the concluding para of the first part of the address Lord Rayleigh has pointed out that the modern scientific doctrines are not based on speculations or theoretical deductions, but have been built up on the foundation of tangible facts discovered by methods not essentially different from direct scrutiny. This mode of direct scrutiny reveals nature as a vacuous pattern of electrical disturbances, and where the centres of disturbances cohere, the experience of solid state is obtained. You want the biological eye to sense the solids; you want the electric eye to perceive that "a particle can be both a particle and a wave". But is the information provided by the latter "Eye" a complete expression of our experience of the visual field of nature? It seems to us that all sense perception is merely an outcome of the dependence of our experience upon bodily functionings, and that the interpretation of the relation of our personal experience to the phenomena of material universe lies in the examination of the dependence of our personal experiences upon our bodily functionings. We may not be near a direct disclosure of the metaphysical nature of things, nevertheless scientific analysis has revealed enough knowledge to enable man to utilise his discoveries for his good as well as for his evil.

We should have been greatly impressed if Lord Rayleigh had chosen as his text for addressing the British Association the other "Vision", which the great founder of Christian Religion preached about nineteen hundred years ago, and on which the whole structure of European civilization purports to be founded. What is the attitude of the great body of British and American scientists who had gathered at Cambridge to discuss scientific papers, while the Central European powers were talking the language of war. For months extending to years the world has been witnessing stupendous developments in the two continents, threatening every nation to be involved in a general conflagration, which is already devastating two countries. Is there a science of peace? or is there only a science of war? It is true that the British Association convened its annual session at a time when the condition of public affairs in Europe was unpropitious for scientists to define their relation to international politics, but a public pronouncement of their intentions in their collective capacity might have helped to unravel the European tangle. We are aware that in the totalitarian states, scientific knowledge is under conscription for military purposes, and we know the extent of reaction which it must produce on the temper of democracies. Political ideologies are fast infecting the spirit of science. There is no recognisable symptom of the change of heart in Dictators towards the horrors and wastefulness of war in which their policies, if pressed to action, must involve their own countries which they profess to love and adore.

Lord Rayleigh has put the case for scientists thus, "It is worth while to enquire what basis there is for this indictment, and whether in fact, it is feasible for men of science to desist from labours which may have a disastrous outcome, or at any rate to help in guiding other men to use and not to abuse the fruits of those labours". His own opinion regarding the general criticism of the application of scientific discoveries in the methods of modern warfare is summarised in a brief sentence, "I believe that the whole idea that the scientific men are specially responsible is a delusion born of imperfect knowledge of the real course of the process of discovery".

Nobody quarrels with scientific discoveries. Nobody suspects the intentions of scientists. Nobody doubts the urge of scientists to explore the unknown. The world is prepared to accept Lord Rayleigh's plea that scientists are not responsible for all the atrocities of war, but it is entitled to ask "then, who is responsible?" He is perfectly right when he says, "I venture to say that it never occurred to him (Sir William Roberts Austen) or to any of his hearers (Lord Rayleigh included) that thermite had any application in war." But surely some one must have had the necessary vision to discover its application to the destruction of civil populations, and is that "some one" a scientist or a politician or a journalist? But the "world is ready to accept the gifts of science, and to use them for its own purposes. It is difficult to see any sign that it is ready to accept the advice of scientific men as to what these uses should be." The world that Lord Rayleigh has in mind is innocent of dichlordiethyl sulphide and is not likely to mix aluminium powder with red oxide of iron, but they form the material on which a few gifted men work and demonstrate their application to the practical uses in peaceful industry. These scientific men are said to have no notion that the "oil, very poisonous and violently inflames the skin," and the "great amount of energy which is liberated when aluminium combines with oxygen" can have any use for military purposes. We believe that there is a wide difference regarding the degree of responsibility attached to scientists investigating theoretical problems and those dealing with explosives and poison gases, and it is untenable to maintain that the entire school of chemists are innocent of the consequences of the products of their researches to the civil populations, or of the possibilities of their employment for military purposes. Will Lord Rayleigh defend the conduct of a well-meaning educationist who in the exuberance of his enthusiasm produces a tiger from the jungle for the purpose of giving the Sunday School children a lesson in natural history and, losing control over the beast, lets it loose on the unoffending boys and girls? Would the school master be justified, were he to protest that "it never occurred to him that the cattle lifter was also a man-eater". At some stage or other in the course of their investigations, scientists must realise the probable directions in which their discoveries might be used, and must also become aware of the consequences of such applications, because they are reputed to be endowed with far-sighted vision, and their faculty of penetration is undoubted. If scientists apprehend that the "world" is morally still in swaddling clothes, would they be justified in willingly placing that excellent and indispensable instrument, the "penknife" into the hands of that injudicious infant? The fact is that deep down in the unconscious part of their minds, scientists are essentially patriots and their desire to defend their homes with mustard gas is perfectly natural and honourable, because the world has not outgrown the spirit of the ancient saying "that all is fair in love and war". That the symbiosis established between science and war in pre-historic times cannot be easily dissociated is refleted in Lord Rayleigh's concluding sentence, "I think we may say that the application of fundamental discoveries in science to purposes of war is altogether too remote for it to be possible to control such discoveries at the source," and the world must for the moment be satisfied with the confession, "frankly, I doubt whether we can do much".

Dealing with the doctrine of pacificism not from the standpoint of sentimentality, but from the standpoint of the facts of human nature and human environment, Lord Raglan has discussed in his little book *The Science of Peace*, what the historical and biological sciences have to say on the origin, development and prevention of war. We confidently hope that the British Association for the Advancement of Science in collaboration with similar Associations in America and in the European countries will, by the formation of the new Division for the investigation of the social relations of science, succeed in finding a satisfactory solution for the vexed problems agitating the world. To the objective study of the social relations of science inaugurated by British scientists whose ultimate ideal must be the establishment of international peace and harmony, India is capable of making significant contributions. Is there perfect agreement among scientists regarding "results" and "methods" of study of the Social Relations of Science?

Lucknow University Studies.

(Faculty of Science.)

WE have received eight neatly bound booklets from the Registrar of the Lucknow University, containing lectures delivered under the auspices of the faculty of science by professors belonging not only to Lucknow, but also to the Universities of Allahabad and Nagpur. These addresses have been published under the Editorial supervision of Professor B. Sahni, F.R.S., Dean of the Faculty, to whose zeal and initiative, this new feature of extra-mural intellectual activities of the University owes its inception. The addresses cover practically all the departments of knowledge embraced by the faculty of science, and they constitute an impressive record of knowledge useful alike to advanced students and to the junior members of the staff. A complete list of reference works is appended to each series of lectures, which must necessarily enhance their value for students engaged in post-graduate studies.

It is one of the legitimate functions of the Universities to portray the part which they play in representing internationally the intellectual activities of their professors and, in furnishing such a picture, the University of Lucknow has, through its "Studies", made an attempt at an organized means, of co-operation, whose results, though premature to assess, may have a far-reaching importance. The subjects which have been selected for the "Studies" include "The Theory and Constructure of Non-differentiable Functions (A. N. Singh); Recent Advances in Indian Palæobotany (B. Sahni); Nitrogen Fixation and Alkali Soil Reclamation (N. R. Dhar); The General Field Theory of Schouten and Van Dantzig (N. G. Shabde)" and others equally important. The scope of these studies is indicated in the preface attached to each series of lectures, and the subjects selected by the authors have been treated comprehensively. Each author has his own individual plan of presenting his topic, but all conform to the general principle underlying the scheme. The reader will find in these studies an ample banquet, and after tasting its sweets, will rise with an appetite.

"Vitaminised" Foods.

WITH the increasing realisation of the fact, that India suffers from an appalling degree of vitamin deficiency, it becomes imperative that the vitamin resources of the country should be fully and systematically explored and a means found to increase their production. The most economical way of achieving this object would be to improve the "quality" of foods—both vegetable and animal—with respect to their vitamin content. Attempts which have been made in this direction, elsewhere, have yielded highly promising results and should constitute the starting point for planning a more comprehensive scheme of investigation.

Feeding cows with irradiated yeast increases the vitamin D content of milk and this observation has been fully utilised in the production of 'vitaminised' milk, which has proved effective in the cure and prevention of rickets in children. A similar enrichment of the vitamin D has been effected in the case of eggs by feeding poultry with irradiated yeast. It is said that one of these eggs contains as much vitamin D as three teaspoonfuls of cod-liver oil.

The pigmentation of the yolk of eggs has been found to intensify by feeding hens with certain types of foods. Hens maintained on a diet of *paprika* lay eggs with intense colour and a remarkably high carotene content. Experiments with unicellular organisms, like yeast, have shown that the composition of the nutrient medium influences the formation of the ribo-flavin, aneurin and other components of the vitamin B complex. The vitamin content of the food forage crops is influenced by the fertility of the soil and particularly by the presence of certain catalytic elements like manganese and boron.

Different Theories of the Spiral Nebulae.*

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HUBBLE found that about 97 per cent. of extra-galactic nabulæ fall into two classes which are more or less regular in shape, *viz.*, (*a*) those which have no spiral arms and are "elliptical" in shape, (*b*) those which possess "true spiral" forms each form consisting of a central region which is rather vaguely defined and from which two spiral arms emerge.

The elliptical nebulæ are classified into eight types, namely, E_0, E_1, E_2, E_3, E_4, E_5, E_6 and E_7, the numerical integer being nearest to $10 \cdot \frac{a-b}{a}$, where a and b are the greatest and the least diameters of the projections of the nebulæ on the sky. We may notice here that E_0 nebulæ are almost circular in shape as in this case $b > 0{\cdot}95\, a$.

Among the spiral nebulæ a much larger number consists of a circular nucleus from which two or more spiral arms emerge, whereas in the second type of spiral nebulæ whose number is much fewer the arms appear to emerge from the ends of a bar-shaped mass.

The remaining 3 per cent. of the nebulæ including the two Magellanic clouds are of irregular shape.

The spiral shapes of the nebulæ raise great difficulties and several theories have been suggested to explain them. We shall discuss briefly the more important theories in this paper.

1. *Jeans' Theory.*—Jeans worked out the case of a rotating compressible mass and obtained a series of configurations with increasing rates of rotation. The surfaces of equi-density will clearly coincide with equi-potential surfaces. Here the minor axis OZ is the axis of rotation. Over the boundary we get $v + \frac{1}{2}\omega^2 (x^2 + y^2) = \text{constant}$. Where ω is the angular velocity. If v_1 be the potential at any point of the equator and v_2 the potential at one of the poles, $v_2 = v_1 + \frac{1}{2}\omega^2 a^2$ (where a is the equatorial radius). If $\bar{\rho}$ is the mean density and b the polar radius, then $M = \frac{4}{3}\pi \bar{\rho}\, a^2 b$ and $v = \frac{\gamma M}{a}$ and $v_2 = \frac{\gamma M}{b}$ approximately.

Jeans thus finds that $\frac{4e}{3} = \frac{\omega^2}{2\pi\gamma\bar{\rho}}$ where ellipticity $e = \frac{a-b}{a}$. From observed ellipticity of nebular forms we can find the values of $\frac{\omega^2}{2\pi\gamma\bar{\rho}}$, and a method can be found out for calculating $\bar{\rho}$.

Bok has applied Jeans' method to Roche's compressible model of a massive point nucleus surrounded by an atmosphere of negligible total mass. He has further assumed that this configuration is rotating with uniform angular velocity around the Z axis. As before the surfaces of equi-density would coincide with equi-potential surfaces.

Let us consider the equatorial section of the configuration. We have at the equator if Ω is the total potential $\Omega = \frac{\gamma M}{a} + \frac{1}{2}\omega^2 a^2$. Also if p be the pressure then, $\frac{dp}{da} = \rho \cdot \frac{d\Omega}{da}$. Therefore $\frac{dp}{da} = \rho\left(-\frac{\gamma M}{a^2} + \omega^2 a\right)$.

If a is small then $\frac{\gamma M}{a^2} >> \omega^2 a$ and $\frac{dp}{da}$ is negative, and so this is a stable configuration since p decreases as a increases.

The pressure gradient vanishes for the value a_0, where $a_0^3 = \frac{\gamma M}{\omega^2}$, we then get $\Omega_0 = \frac{3}{2}\omega^2 a_0^2 = \frac{3}{2}(\omega\gamma M)^{\frac{2}{3}}$

So the equation for the limiting equi-potential surface becomes $\frac{1}{2}\omega^2 (x^2 + y^2) + \frac{\gamma M}{r} = \frac{3}{2}(\omega\gamma M)^{\frac{2}{3}}$.

The critical value of the mean density is obtained from $\frac{\omega^2}{2\pi\gamma\bar{\rho}} = 0{\cdot}36$.

Bok suggests that for $\bar{\rho} > \rho_0$, the surplus matter would probably stream out in equatorial plane.

* From a lecture delivered at the Mathematical Conference, Lucknow, March 16, 1938.

Jeans supposes that as soon as the ellipsoidal nebulæ becomes unstable, gas will be ejected out in the equatorial plane along the spiral arms and ultimately stars would be formed by condensations along these arms.

The main difficulty in Jeans' theory is that he supposes that ellipsoidal nebulæ by their very nature are gaseous in composition and this is not corroborated by observation. His theory rules out the possibility of star clouds existing in ellipsoidal nebulæ. This is also not verified by observation. Our own galaxy is probably a highly flattened system of ellipsoidal form and is known to contain many star clouds.

Lindblad has also calculated the mass of the Andromeda nebula and he has found that the luminous part of the nucleus is composed mainly of stars like our Sun.

The observed spectra of ellipsoidal nebulæ cannot be explained by Jeans' theory about their composition.

Jeans' theory would give a long-time scale for the age of stars which are believed to be formed in the spiral arms of the nebulæ but Bok has pointed out that long-time-scale presents many difficulties which would disappear if you accept the short-time-scale.

2. *Brown's Theory.*—Brown assumes that originally every spiral nebulæ was a highly flattened homogeneous ellipsoid of revolution inside which the gravitational force of attraction is of the form $-Ax$, $-Ay$, $-Cz$. Later on, minor variations in the uniform density are assumed to be due to perturbations caused by rather close encounters with passing galaxies. These perturbations also lead to the formation of the spiral arms of the nebulæ. Brown further concludes that after the encounter the spiral arms gradually coil up and the nebulæ ultimately reverts to its original ellipsoidal shape. According to him the spiral form is not a permanent structure and its formation is being repeated more or less periodically by encounters.

Inside the homogeneous ellipsoid of revolution all stars will have the same angular velocity. Brown superposes on the uniform density, the additional small density $\delta_1\sigma = \lambda \cos\left(2\phi - 2q \log \frac{r}{a} - 2a\right) \sin^2\theta$, where $\lambda << $ constant density. Here r and ϕ are the co-ordinates in the equatorial plane and θ is the angle which the radius vector makes with the polar axis. We now see that $\phi - q \log \frac{r}{a} = a$ is equation to an equiangular spiral.

We may also notice here that the factor $\sin^2\theta$ in the superposed density leads to rapid density decrease perpendicular to the equatorial plane. Here q is the tangent of the angle which the radius vector makes with the tangent at any point of the spiral. As the superposed density is a periodic term, it may cause the resonance trouble. So in Brown's theory it is necessary to add another term $\delta_2\sigma = -\mu \log \frac{r}{a}$, where μ is of the same order of magnitude as λ. This extra term leads to a gradual density decrease as r increases.

We also find that on account of superposed density the rate of angular motion is slower in the front regions than in the back regions. Hence it leads to the gradual coiling up of the spiral like a watch spring.

Assuming the density of galaxies in intergalactic space to be 10^{-72}, Brown calculates that in every 10^{12} years there will be an encounter which would lead to spiral formation. There is one great drawback in Brown's theory—apart from the small superpositions he assumes uniform density throughout the galaxy even perpendicular to the equatorial plane; but this is not borne out by observation. Moreover there is also no evidence yet to show that spiral formation is a periodic phenomenon.

3. *The Theory of Vogt and Lambrecht.*—In accordance with this theory most of the mass of the spiral nebulæ is supposed to be concentrated in the nucleus. So that everywhere outside the nucleus the gravitational force may be taken to vary as $\frac{1}{r^2}$, r being the distance from the centre of the nucleus. In addition to the force of attraction they assume that there is also a force of repulsion proportional to the distance from the centre of nucleus. If h is the areal constant, $u = \frac{1}{r}$ and θ is the position angle, we get our equation $\frac{d^2u}{d\theta^2} + u = \frac{\gamma M}{h^2} - \frac{a^2}{h^2u^3}$. From this

we get,

$$\theta + \text{const.} = \int \frac{dr}{r^2 \sqrt{\frac{2\gamma M}{rh^2} + \frac{a^2 r^2}{h^2} - \frac{1}{r^2} + c}}.$$

If a^2 has a small value between 0 and $\frac{\gamma M}{r^3}$ then spiral orbits will be formed. For large values of a^2 convex hyperbolas will result.

Vogt finds that for Andromeda nebula a^2 is small and equal to $\frac{1}{50}\frac{\gamma M}{r^3}$.

Criticism of Vogt's Theory.—The main objection to Vogt and Lambrecht's theory is the assumption of the force of repulsion. They did not give any explanation of its cause. It is analagous to cosmic force of repulsion in Einstein's theory of Relativity which is believed to expalin the so-called phenomenon of recession of galaxies. The theory does not satisfactorily explain why should there be two arms in the spiral nebulæ. Lambrecht tries to explain it by ascribing it to encounters. Moreover there is no justification in assuming that the mass is concentrated in the nucleus. Hacker has also criticised Vogt's theory. He has pointed out that the spiral orbits would also have a point of inflexion. Moreover the form of the spiral orbit as given by Vogt's theory does not very well agree with the observed spiral arms of the nebulæ. The orbit according to Vogt's theory proceeds rather steeply outwards after reaching the point of inflexion.

4. *Lindblad's Theory.*—Lindblad assumes that there is a small condensed nucleus which is surrounded by a spheroidal galaxy of stars of uniform density from which spiral arms emanate. He takes the mass of the nucleus to be λM and the total mass to be $(\lambda + 1)$ M. For orbits in equatorial plane Lindblad gets the equation

$$\left(\frac{du}{d\theta}\right)^2 = -u^2 + \frac{2}{h^2}\int \frac{f}{u^2}\,du,$$

where $f =$

$$\frac{\lambda\gamma M}{r^3} + \frac{3}{2}\frac{r\gamma M}{a^3 e^3}\left[-\frac{ae}{r}\sqrt{1-\frac{a^2e^2}{r^2}} + \text{arc sin}\,\frac{ae}{r}\right]$$

where e is the eccentricity of the meridional section, a is the semi-major axis and θ is the longitude. f is measured positively towards the centre. The first term in f arises from the nucleus and the remaining terms from the outer ellipsoid of revolution.

After substituion and integration we get

$$\left(\frac{du}{d\theta}\right)^2 = -u^2 + \frac{3}{2}\cdot\frac{\gamma M}{h^2 a^3 e}\left[\left(2a^2 - \frac{1}{e^2u^2}\right)\right.$$

$$\text{arc sin}\,aeu + \frac{a\sqrt{1-a^2e^2u^2}}{eu} + \left.\frac{4}{3}\lambda a^3 eu\right] + c.$$

Lindblad has proved that tidal action will cause a slight perturbation which will not change h but will increase c by a small amount δc. Lindblad has put symbolically the above equation as $\left(\frac{du}{d\theta}\right)^2 = \phi(u) + c$.

If $\frac{1}{u_0}$ be the semi-major axis of undisturbed elliptic orbit just before perturbation, then the spiral form would be possible provided $\phi''(u_0)$ is positive. If $\phi''(u_0)$ is negative no spiral form is possible. So when $\phi''(u_0) = 0$, we get the transitional case. If there be little mass in the nucleus, that is if λ is small, there is great possibility for the formation of the spiral arms.

Lindblad's Recent Investigations.—In a recent paper Lindblad has assumed that the stellar system may be divided into a number of sub-systems of approximately the same extension in the galactic plane but with different degrees of flattening towards this plane and different speed of rotation at the same distance from the axis.

The sub-system of greatest flattening towards the galactic plane is represented by the Milky Way clouds and one of the smallest flattening and smallest velocity of rotation is represented by the distant globular culsters. He also assumes that no given natural system of objects would belong to a single sub-system, but would spread over a number of such sub-systems. Spectro-graphical determinations of the rotational motions of the nebulæ show a fairly uniform angular speed of rotation in the central parts of the systems. It is extremely probable that in the outer less dense regions, the angular velocity is far less than in the central parts and that in these regions it decreases rapidly.

Perhaps the transition between these two states of motion is fairly rapid. Lindblad has shown that asymptotic spiral orbits will naturally occur in such cases. Moreover due to the escape of high velocity objects and formations of condensations all rotating systems will become flattened with age and the condition that is necessary for formation

of asymptotic spiral orbits will automatically be realised after some time.

Lindblad has shown that in the outer regions of the central system there would be a marked tendency towards a formation of local condensation of matter. He suggests that as the result of an encounter between two such condensations near the edge of the spheroidal system, one condensation may move in an asymptotic orbit and cause the "initial disturbance" to produce the spiral form. So according to him tidal ejections due to outside cause such as encounter with passing galaxies, are not essential for the formation of two or more spiral arms.

Lindblad has also suggested, contrary to Vogt, that the points of ejections should have a tendency to recede relatively to the matter at the edge of the central system in opposite direction to the rotation. It is quite possible that these points of ejections may be fixed in space. According to Lindblad when the spiral arms are fairly thin, the decrease of size and mass of the central system may be neglected and spiral arm may without much error be supposed to indicate the real orbit of a single particle of the arm (M. 81). In the case of nebulæ of heavier arms continuous decrease of the central body by the formation of arms must be taken account of and the arm no longer represents exactly the orbit of one of its particles (M. 51).

Lindblad's theory seems to be much more tenable than any other theory so far put forward as he does not make any untenable assumption concerning the structure of ellipsoidal and spiral nebulæ.

Wellman's Theory.—Wellman has assumed that a slow expansion of the system due to a secular decrease of its mass would make all elliptical orbits of the system take the shape of very close spirals. He assumes that there is a difference in the rate of expansion between outer and inner orbits and that the spiral arms are the loci of the ejected matter that comes out as a steady outflow from diametrically opposite points of the system. Although these assumptions are very interesting they can hardly be applied to the actual system.

Jehle has tried to explain the spiral arm by generalised theory of wave-mechanics.

Narlikar and Moghe have suggested that the two-dimensional geodesics of an expanding spherical universe have spiral arms, but their theory has been criticised by McCrea. Narlikar has also replied to the criticisms of McCrea.

In conclusion, it may be mentioned that no satisfactory theory about the formation of spiral arms can be established until and unless we can have a more thorough knowledge of the constitution of the galaxy. The recent investigations by Plaskett and Pearce tend to show that inter-stellar matter extends throughout the local cluster and that there is a gaseous substratum involving the local system and perhaps extending beyond it "a continuum rather than a cloud". They have also found that the inter-stellar diffused matter partakes in the rotation of the galaxy and they believe that the whole galactic system is immersed in a gaseous substratum consisting of atoms of various elements, the density being of the order of 10^{-26}. "The separate atoms while obeying the ordinary gas laws partake in a rotational movement around a distant central mass in galactic longitude 325°. The observed rotational accelerations seem to be the same as for the stars so that the atoms are not subjected to any appreciable radiation pressure from the central mass."

From observational matter now available we may accept the view that the space in our stellar system, at least to the distance observed, is pervaded by very diffuse matter in the gaseous form of a composition similar to stellar matter and ionised by general radiation of stars.

The authors are studying the problem of the spiral arms by assuming a central rotating homogeneous mass of finite dimensions (not small) surrounded by a rotating gaseous and ionised matter of low density, so that apart from the gravitational forces, electrical forces are also to be taken into account.

"The Nebulæ," *Hand Buch der Astrophysik*, 5.
Jeans, *Astronomy and Cosmogony*, Chap. XIII.
Lindblad, *Contribution to the Theory of Stellar System.*
Bok, *Notes on Spiral Structure*, 1936; *Harvard Circular*, 1934, **384**.
Peek, *M.W.*, **92**, 707; **93**, 152.
Hacker, *A.J.*, 1933, **42**, 46 (Astron Nachr).
Vogt, *A.N.*, 1935, **257**, 1; **254**, 113; 1932, **245**, 281; **247**, 167; 1933, **249**, 195; **259**, 113.
Lindblad, *Stockholm's Annals*, **12**, No. 9, 19, 20 and 24.
Lambrecht, *A.N.*, 1935, **254**, 113.
Narlikar and Moghe, *Observatory*, 1935, **58**, 366.
McCrea, *ibid.*, 1936, **59**, 19.
Wellman, *Zeitschrift für Astro-physiks*, 1935, **9**, 47.
Jehle, *Zeitschrift für Physik*, 1934, **87**, 370; 1935, **94**, 692.

Donnan Equilibria in Biological Processes.

By K. R. Dixit.

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The Living Cell as an Osmotic System and Its Permeability to Water.[36]

IF the living cell behaves as an osmotic system, we can apply thermodynamics, and the values of the constants like molecular weight obtained by using the cells as osmometers, should agree with those found by means of non-living systems.

A typical mature plant cell may be considered as consisting of a solution of various electrolytes and non-electrolytes (the cell sap) enclosed in a semipermeable membrane, the extremely thin protoplasmic layer (protoplasm). The latter forms a closed sac lying against the semi-rigid cellulose wall (the cell wall) which in most plants is permeable both to water and solute. The pressure exerted by the sap keeps the cell wall under a certain tension to which is due the normal state of rigidity (turgor) of the cell. When a plant cell is placed in pure water or in a solution hypotonic with respect to its contents, entry of water due to end-osmosis is generally prevented by the rigidity of the wall. When on the other hand, a cell is placed in hypertonic solution, exosmosis occurs, the sap diminishes in volume and the encircling protoplasmic layer retreats from the cell wall, which loses its tension. By placing cells of the same kind in solutions of graded concentration it is possible to find for each solution that particular concentration in which plasmolysis is barely perceptible.

H. de Vries[37, 38] using the leaf cells of *Tradescantia discolor* as osmometers determined the molecular weights of raffinose and sucrose. Similarly, the cells of *Spirogyra* were used as osmometers by Overton.

Probably no other kind of animal cell has been as extensively employed for investigation of osmotic phenomena as the red blood cell. These isolated cells are easily obtained at any time and in any desired quantity, they have relatively a simple structure, they can be kept in usable condition for a longer period of time than any other kind of cell, and unlike many other isolated cells erythrocytes show no seasonal variation. Its osmotic properties are perhaps more influenced by slight environmental changes than is the case with any other kind of cell. In common with other cells the erythrocyte is freely permeable to a great variety of organic compounds whereas it is impermeable to salts as such. However, unlike most other cells, the erythrocyte is permeable to many anions, so that the exchange of anions may take place between the cell and its surrounding medium. For example, it is well known that HCO_3^- when its amount increases in the blood corpuscle, is exchanged for Cl^- from the plasma. Hamburger[39] first established the fact that the relative osmotic pressure of solutions may be determined by using the erythrocyte as osmometer. Equally convincing experiments were performed by Kœppe,[40] Hedin,[41] and others.

As in the case of plant cells it is possible with a muscle to determine the strength of a solution in which the muscle neither gains nor loses water (a solution which is isotonic with the muscle). Such experiments show that both plant and animal cells obey the laws of osmosis (based on thermodynamics) so long as they remain alive and uninjured, *i.e.*, as long as the semipermeability of their surfaces is preserved.

Similar experiments have been performed with leucocytes and spermatozoa,[42–44] muscles such as the gastrocnemius or sartorius of frogs,[45] with certain plant cells of regular geometrical form like the parenchymatous cells of the stem of *Tradescantia elongata*,[46]

[36] Luckè and McCutcheon, *Physiological Reviews*, 1932, **12**, 68.

[37] H. de Vries, *Zeit. Physik. Chem.*, 1888, **2**, 415.

[38] H. de Vries, *Bot. Zeit.*, 1888, **46**, 394.

[39] Hamburger, *Arch. F. Physiol.*, 1886, 476.

[40] Kœppe, *Zeit. Physik. Chem.*, 1895, **16**, 261.

[41] Hedin, *ibid.*, 1895, **17**, 164.

[42] Hamburger, *Archiv. F. Physiol.*, 1898, 317.

[43] H. Kœppe, *ibid.*, 1895, 154.

[44] H. Kœppe, *ibid.*, 1899, 504.

[45] R. Beutner, *Biochem. Zeit.*, 1913, **48**, 217.

[46] K. Höfler, *Ber. deutsch. Bot. Gesellsch.*, 1917, **35**, 706.

with yeast cells,[47] and also with egg cells of Echinoderms, *Arabacia punctalata*.[48]

Cramer[49] has formulated the problem of permeability of water as follows: "Is the water content of the living cell dependent entirely on osmotic forces or is it dependent also on the inhibition of the lyophilic colloids of the cell content?" In the former case, the water would be entirely free, in the latter a fraction of water would be bound and incapable of taking part in osmotic exchange. Gortner,[50] however, points out that there is 'an insensible gradation from water which is an integral part of protoplasmic structure to that which is simply the medium in which the protoplasm is suspended'.

It is well known that electrolytes play a prominent rôle in the properties of cells. The effect of low concentrations of electrolytes on permeability to water has been investigated by the use of unfertilised *Arabacia* egg.[51] These experiments clearly showed that chlorides of univalent cations tend to increase permeability to water, while those of bivalent cations tend to reduce permeability, to its value in sea-water. It is reasonable to infer that the low permeability values obtained in sea-water are dependent on the presence of Ca and Mg.

Effect of activation (fertilisation) of echinoderm eggs on the permeability to water has been investigated, and of the many chemical and physical changes that occur in the egg cell on fertilisation, its increased permeability to water-soluble and diffusible substances is regarded by Lillie[52] as of fundamental importance. Evidences of such permeability change, quoted by Lillie, are increased electrical conductivity, the readier entrance of substances like alkali and certain dyes, the loss of certain substances (*e.g.*, pigment), from the fertilised egg, and the fact that pure isotonic solutions of sodium salts, which are known to increase permeability and to serve as activating agents, do neither in the presence of calcium or magnesium salts or anæsthetics.

In this connection the observation of Loeb[53] is recalled that parthenogenetic agents are in general cytolytic ones. This is true of the pure salt solutions and acids (*e.g.*, butyric) ordinarily used to activate the egg artificially, as well as agents less often used, such as electric currents, heat and mechanical stimulation. Lillie sees a close connection between the activating effects of these agents and their stimulation of irritable tissues. In the case of both activation and stimulation he regards the first step as the increase in permeability of the cell surface, as the result of which occurs a change in electrical polarisation; electrical changes, he regards, as the critical phenomena which brings about either activation or stimulation.

Lillie also concludes that fertilised eggs are several times more permeable to water, than are unfertilised ones. The increase in permeability is not instantaneous. It begins probably 2 to 4 minutes after insemination and is in greater part completed during the next 10 minutes.

The permeability of the unfertilised egg of the seaurchin, *Arabacia*, is about 0·1, in the fertilised state it increases two to four times, while the permeability for the human red corpuscles is of the order of magnitude 3·0. In membranes of living systems an extreme range of permeability is found from practically complete impermeability to free permeability. Thus, under certain conditions, the membrane of the egg of Fundulus is practically impermeable to water; the other extreme is found in the cellulose wall of many plant cells which permit free diffusion of water.

Donnan Equilibrium in Blood-Corpuscles.[19,20]

E. Warburg[15] was the first to apply the theory of Donnan Equilibria to red blood-corpuscles, and considerable progress has been made during the last few years.[16, 17] It is well known that the red corpuscles do not possess any nucleus, and as a result the metabolic processes are either completely absent or play an unimportant part. Further these cells are impermeable by micellæ and simple cations like Na^+, K^+ but are permeable to anions like HCO_3^-, Cl^-. Thus all the necessary conditions for Donnan

[47] K. T. Wieringa, *Protoplasma*, 1930, **8**, 522.

[48] McCutcheon and Lucké, *Journ. Gen. Physiol.*, 1931, **14**, 393.

[49] W. Cramer, *Trans. Farad. Soc.*, 1930, **26**, 686.

[50] R. A. Gortner, *ibid.*, 1930, **26**, 678.

[51] McCutcheon and Lucké, *Journ. Gen. Physiol.*, 1928, **12**, 129 and 571.

[52] R. S. Lillie, *Amer. Journ. Physiol.*, 1916, **40**, 249.

[53] J. Loeb, *Science*, 1913, **37**, 427.

equilibrium are apparently fulfilled, and this equilibrium condition between the liquid within the cell and the serum outside it may be represented diagrammatically as follows :

Red corpuscle.			Serum.		
Hb					P
Hb^-	B^+	a	x	B^+	P^-
Cl^-		b	y		Cl^-
HCO_3^-		c	z		HCO_3^-
(1)			(2)		

where B^+ = sum of the cations Na^+ and K^+.
Hb = hæmoglobin.
Hb^- = hæmoglobin anions.
P = serumprotein.
P^- = serumprotein anions.
a, x, etc., are the concentrations.

The red corpuscle also contains other proteins besides hæmoglobin, but they are present in such small quantities that they may be neglected in an approximate calculation. Further in order to simplify the calculations, we shall assume that both the solutions are dilute and ideal or the simple theory of Donnan[4] can be applied to the system.

Hence

$$\frac{(Cl^-)_1}{(Cl^-)_2} = \frac{(HCO_3^-)_1}{(HCO_3^-)_2} = \frac{(Cl^-)_1 + (HCO_3^-)_1}{(Cl^-)_2 + (HCO_3^-)_2} = r,$$

where the brackets denote as usual the molar concentrations. With the same assumptions the conditions of the osmotic equilibrium give the following relation

$$(B^+)_2 + (Cl^-)_2 + (HCO_3^-)_2 = (B^+)_1 + (Cl^-)_1 + (HCO_3^-)_1 + (Hb)$$

where (Hb) is the total concentration of hæmoglobin in the cell. These two relations give for r the following relation :

$$r = \frac{b+c}{y+z} = 1 - \frac{a + (Hb) - x}{2(y+z)} = 1 - \frac{a + (Hb) - x}{2[(B^+)_2 - x]}.$$

A study of the chloride and bicarbonate distribution between plasma (venous) and spinal fluid, and plasma and ascitic fluid has been made by Muntwyler, Way and Pomerene[54] and they conclude that the concentration and distribution of electrolytes in body fluids are governed by the factors outlined for the Donnan equilibrium. But their results as well as those of Hastings and others[55] show that $\frac{(Cl^-)_1}{(Cl^-)_2}$ is slightly less than $\frac{(HCO_3^-)_1}{(HCO_3^-)_2}$ which means that the conditions for the simple Donnan equilibrium are nearly but not exactly fulfilled. But this is what could be expected for in the simple theory we assume that both the solutions are very dilute and ideal, and we neglect the possibility of the formation of the ioncomplexes as well the adsorption of the ions. For a better agreement, more exact theory will have to be developed.

We have seen that the red corpuscles are not permeable by the cations, but Robinson and Hegnauer,[56] performed experiments with the plasma of cats and rabbits (which have received large intraperitoneal injections of isotonic glucose) and they conclude that when the electrolyte balance of the plasma is sufficiently altered, the red blood cell membrane may become somewhat permeable to cations.

Physico-Chemical Factors Affecting Intra-ocular Liquid.[57]

The earliest conception of the nature of the intra-ocular fluid was that it represented a secretion by the epithelium of the ciliary body, a conception based on insecure and inadequate evidence, mainly anatomical in nature. During the last thirty years there has existed alongside this view, the theory that the fluid in the anterior chamber was formed by simple filtration from the capillaries of the eye. Later physico-chemical researches of Duke-Elder[58] have given rise to the theory that this fluid is essentially a dialysate. We shall describe here the work of Duke-Elder[58] in detail.

The constituents of the serum are present in the intra-ocular fluid, these constituents may be divided into three groups of substances depending on the physical state of their molecules in solution, colloids, non-ionised and ionised crystalloids. All the substances

[54] Muntwyler, Way and Pomerene, *Journ. Biol. Chem.*, 1931, **92**, 733.

[55] Hastings, Sendroy, McIntosh and Dyan Slyke, *ibid.*, 1928, **79**, 193.

[56] Robinson and Hegnauer, *ibid.*, 1936, **116**, 779.

[57] W. S. Duke-Elder, *Physiological Reviews*, 1934, **14**, 483.

[58] Duke-Elder, *Biochem. Journ.*, 1927, **21**, 66.

in colloidal aggregation are found in the intra-ocular fluid, but in much less concentration than in serum; proteins, fats, immune bodies and ferments. All the proteins of the plasma are found in the intra-ocular fluid, they are found here in the same relative proportions in which they occur in blood, and they are specifically identical. They thus appear to remain unchanged in their transit from the blood-vessels to the eye. The diffusible non-dissociated substances are partitional between the intra-ocular fluid and the blood serum in approximately equal amounts. The more important constituents are sugar urea and the non-protein N. The dissociated diffusible substances are unequally distributed. In each case the cations have a partition coefficient > 1, and the anions a partition coefficient < 1, the former being in less and the latter in greater concentration in the intra-ocular fluid than in the serum. Cations are Na, K, Ca and Mg and the anions are Cl', SO_4'' and PO_4'''.

Duke-Elder finds that the osmotic pressure of the intra-ocular fluid is less than that of the capillary plasma by an amount determined by the excess of colloids in the latter. It is a small fraction only (about 0·3 to 0·5 per cent.) of the total osmotic pressure (approximately 6,000 mm. Hg).

Duke-Elder also studied the intra-ocular fluid formed under abnormal conditions :

(1) In the first series of experiments the permeability of the capillary walls is altered. He finds that when the permeability is increased very definite changes take place in the chemical and physical properties of the intra-ocular fluid, which are essentially the same no matter what method is employed to alter the permeability. The fluid so formed differs from the normal by approximating more nearly to the constitution of the plasma. The colloidal non-diffusible substances—proteins etc., are increased. The colloidal non-diffusible substances which are not ionised, such as sugar, are practically unchanged in concentration. The ionised salts are partitioned unequally; the negatively charged anions show a diminution, and the positively charged cations an increased concentration. In a similar way physical properties vary in the direction an excess of colloids would lead us to expect.

(2) In the second method Duke-Elder altered the composition of the blood, either by varying the concentration of the normal constituents or by adding new substances to it. (This is of importance from the point of view of the local availability of drugs in the eye.) He finds that colloidal substances enter the eye, only in traces, if at all. Diffusible substances which are not ionised enter the eye freely, rapidly attaining therein a concentration equal to that in the plasma. Diffusible substances which are ionised behave in a manner depending on their electric charge. Anions—negatively charged substances like chlorides—readily pass into the eye, but cations do so only with difficulty.

Duke-Elder[59] analysed this experimental data, and assumed that the simple theory of Donnan may be applicable to this system. If Donnan's theory is applied the condition of equilibrium could be diagrammatically represented as follows :

Capillary blood.		Aqueous humour.
$Na^+ \begin{cases} P^- \\ Cl^- \end{cases}$		$Na^+ \quad Cl^-$
(1)		(2)

where P = protein. This gives the theoretical relation

$$(Na^+)_{aq.} \times (Cl^-)_{aq.} = (Na^+)_{blood} \times (Cl^-)_{blood.}$$

Duke-Elder[59] found experimentally that L.H.S. = 148·8 and R.H.S = 149·3, which is a very satisfactory agreement with the theory.

Based on this experimental data, the theory of dialysation was elaborated by Duke-Elder; that the intra-ocular fluid is in thermo-dynamical equilibrium with the capillary blood, and is a dialysate of it, the dialysing membrane being the capillary walls. It is thus comparable in its origin and metabolism with the tissue fluids elsewhere, and differs from them qualitatively only as a consequence of the relative impermeability of the capillaries of the eye. The capillaries vary in their permeability throughout the different tissues of the body, being adapted to suit the needs of each particular organ, and their almost complete impermeability in the eye may

[59] Duke-Elder, *The Nature of Intra-ocular Fluids*, London, 1927.

be regarded as a biological adaptation to keep the intra-ocular fluid as far as possible free from colloidal substances so that it remains optically homogeneous.

Swelling of Protein Gels.[20]

The swelling of proteins is a subject of exceptional importance. The swelling of silk, cotton and wool fibres, of cellulose, and of various other plant and animal tissues, are the examples of this type of swelling. We have to deal with this type of swelling in the various manufacturing and biological processes.

A dry leaf of gelatin will, when placed in pure water, take in water and swell. This phenomena of imbibition-swelling can be prevented by applying pressure to the gel, and this equilibrium swelling-pressure may reach very high values when the gel contains only a relatively small proportion of the solvent. The nature of the intra-micellar or extra-micellar forces that determine this taking in of water are not yet fully understood. There exists, however, an apparently different sort of swelling, which we may call secondary or osmotic swelling. A piece of gelatine which has been fully swollen in pure water will show a further and much greater swelling in dilute acid or alkaline solutions. The forces concerned here are not great and a relatively small pressure is sufficient to prevent this type of protein swelling.

Procter and Wilson[60–62] consider this as a special case of Donnan's general theory of membrane equilibria. When gelatin is immersed in a dilute solution of an acid, combination takes place between gelatin molecules and the hydrogen ions, resulting in the formation of an highly ionisable salt of gelatin (formation of a non-diffusible gelatin cation), the anion of which is tending to diffuse, and exerts on the jelly mass an outward pull, which produces an increase in the volume of the jelly proportional to the magnitude of the pull. In pure water, combination must take place, although probably only to a very slight extent between the gelatin molecules and the hydrion of the slightly dissociated water, leaving in the jelly a corresponding excess of hydroxyl ions which tend to diffuse outward causing the jelly to swell. According to the simple theory of Donnan the ionic products on each side of the jelly-water interface are equal, but the sums of the diffusible ions in the two systems are unequal. This inequality of the diffusible ions in the two systems causes an osmotic pressure in the jelly, which is greater than the osmotic pressure in the external fluid. This osmotic excess is the force which causes the jelly to swell, there is also a counterforce due to the elastic properties of the framework.

Procter carried out experiments to verify the theory. He assumed that the gelatin salt is completely ionised. If GH^+ represents the gelatin ions, *i.e.*, gelatin molecules combined with H^+, the state of equilibrium is represented diagrammatically as below :

Jelly.		External solution.	
z	$G\,H^+$		
y	H^+	H^+	x
$y+z$	Cl^-	Cl^-	x

and $y(y+z) = x^2$. Procter found that this equation is satisfied qualitatively.

On the quantitative side the original Procter-Wilson theory gives only a rough approximation and requires modification in the light of later knowledge.[63] Procter-Wilson theory of gelatin swelling is based on the Donnan equations,[4] and these were worked out for diffusion into a volume sufficiently large, or for very dilute ideal solutions only. Experiments carried out on such systems show that as soon as structure begins to appear in a system, the simple calculations based on Donnan's equations[4] can no longer be applied in their unmodified form.

Donnan's original equations start with the assumptions that though the colloid ion is under mechanical restraint, all other ions and molecules are free from mechanical restraint. This hypothetical case is realised in a system where a membrane divides an entirely fluid system, *i.e.*, where the colloid is a sol, but as soon as we turn to consider gels, a different state of affairs make itself manifest. Ions and molecules can diffuse

[60] H. R. Procter, *Journ. Chem. Soc.*, 1914, **105**, 313.

[61] Procter and Wilson, *ibid.*, 1914, **109**, 307.

[62] Wilson and Wilson, *Journ. Amer. Chem. Soc.*, 1918, **40**, 886.

[63] D. Jordon-Lloyd, *Journ. International Soc. Leather Trades' Chemists*, 1933, **17**, 208.

through weak gelatin jellies as freely as through water, but as soon as the gel has a setting concentration of more than about 15% this is no longer the case, and by a time a 20% setting concentration is being considered, the hindrance to the migration of both water and dissolved substances is being considerable. In the tissue such as a muscle there is about 25% of protein and there is still a fair amount of freedom of movement for small molecules and swelling due to the establishment of Donnan equilibria takes place in acid and alkaline solutions. In skin where the protein concentration has increased to 35%, the freedom of movement of small molecules is still further reduced and the osmotic swelling is reduced accordingly. When we come to the group of fibres which in equilibrium with water contain 25 to 30% of water to 75 to 70% of protein, the structural arrangements of the long protein molecules must be such that nothing but long, fine capillaries remain for the small molecules to diffuse through, and the rate of diffusion is impeded. The mere crowding together of protein molecules leads to a reduction of the space available for free water and calls for the introduction of new and unknown factors into the simple equations.

Ionic Nature of Enzymes.

The Donnan equilibrium furnishes a test for the ionic nature of any diffusible substance,[64] since the ratio of the concentration of any ion on the two sides of a membrane must be equal to the ratio of the concentrations of any other ion of the same sign and valence, whereas a non-ionic substance would be equally distributed on both sides. Expressed mathematically the equation is

$$\frac{(A_0^{-n})^{1/n}}{(A_i^{-n})^{1/n}} = \frac{(B_i^{+m})^{1/m}}{(B_0^{+m})^{1/m}} = \frac{(C_i^{+l})^{1/l}}{(C_0^{+l})^{1/l}}$$

in which (A_i) is the concentration of an n valent negative ion inside the membrane, (A_0) is the concentration of the same ion outside. B, C, etc., are any other diffusible ions present, having the valence m, l, etc. In order to test the ionic nature of a substance, therefore, it is only necessary to set up such an equilibrium system, measure the concentrations of some ion such as hydrogen or chloride and compare this ratio with the concentration ratio of the substance under investigation. The only difficulty lies in the fact that the equation predicts only the concentration of the ions and not the total concentration, so that if the substance is not completely ionised, or is combined in non-ionic form in the solution, the determination of the total concentration will not lead to the correct ratio. In other words, if the experimental results do not agree with the ratio, the discrepancy may be due to complicating factors and no definite conclusion can be drawn, whereas if they do agree, the conclusion seems justified that the substance is ionic.

Northrop applied this method to the distribution of trypsin and found that trypsin behaves like a monovalent positive ion from pH 2 to 10·2.[64] At this point it behaves as though it were unionised and on the alkaline side of 10·2 becomes a monovalent negative ion. The experiments in this strongly alkaline range, however, are not satisfactory. Northrop[65] has also found that the ratio of the concentration of pepsin inside of gelatin or egg albumin particles to the concentration outside is approximately equal to the ratio of chloride or bromide ion under the same conditions. This is true over the range of pH from 1 to 7, and in the presence of various salts and acids. It follows, therefore, that pepsin is monovalent anion, and also that the enzyme does not form a compound with gelatin nor is the degree of dissociation affected by changes in pH in the range in which the enzyme is active. The enzyme becomes very unstable on the alkaline side of pH 7.

We shall now describe certain reactions which at least qualitatively can be explained on the basis of Donnan's theory. For example, it has long been known that dilute solutions of certain electrolytes will stimulate the action of enzymes. Falk[66] showed that dilute solutions of $MnSO_4$, $MnCl_2$, $MgSO_4$, $CaCl_2$ and $BaCl_2$ increased the activity of castor bean lipase toward ethyl butyrate. Calcium and magnesium salts accelerate tryptic digestion,[67] aluminium sulphate and monophosphates in dilute

[64] J. H. Northrop, *Journ. Gen. Physiol.*, 1924, **6**, 337.

[65] Northrop, *ibid.*, 1925, **7**, 603.

[66] Falk, *Journ. Amer. Chem. Soc.*, 1913, **35**, 601.

[67] Cole, *Journ. Physiol.*, 1904, **30**, 202 and 281.

solution have been found to stimulate enzyme activity,[68] potassium bromate in low concentrations stimulates the digestion of casein by trypsin.[69] Not only is it possible to stimulate the activity of enzymes with salts but their presence is also capable of increasing enzyme production by microorganisms.[70]

In a series of papers dealing with the properties of an *antistaphylococcus* phage and its mode of action on a strain of *Staphylococcus aureas* Krueger[71] has shown that : In a mixture of phage and growing bacteria, phage in or on the cells is in equilibrium with the phage free in the medium. Phage formation is intimately related to bacterial growth and as far as can be determined does not occur in its absence. Phage can be completely inactivated by high concentrations of $HgCl_2$ and subsequently can be reactivated by removal of the Hg^{++} ions. Similarly inactivation with KCN can be reversed by conversion of the CN^- into $Ag(CN^-)_2$.

Krueger and West[71] performed experiments in connection with the accelerating effect of manganous salts on phage action. These experiments show that the accelerating effect is not due to a stimulation of bacterial growth nor to an enhancement of phage formation. There is a clear-cut lowering of the lytic threshold and also a change in the distribution of the phage between the bacterial cell and its environment. The Mn^{++} ion increases extracellular fraction at the expense of the phage fraction associated with the cell.

Padoa and Tedeshi[21] attempted to determine the membrane potential of oxidase and peroxidase (which are Fe and Mn containing the enzymes) in contact with an ionisable salt of the same ions. They find that under proper experimental conditions it is possible to determine at which pH the Mn^{++} ceases to act as a catalyst, it is between pH 6·2 and 6·4.

Physico-chemistry of Cheddar Cheese Making.

McDowall and Dolby[72] find that there is a definite evidence of the existence of a Donnan equilibrium which controls the partition of ions between curd and whey and which also involves an osmotic effect which determines the concentration of non-electrolytes after salting. They show that after salting there is a pronounced fall in the concentration of calcium, a much less pronounced fall in phosphate and lactate, and a rise in sulphate in the wheys. With curd salted at an earlier stage than the normal, the whey contained a higher concentration of lactate/water, than did the whey from another portion of the same curd which had not been salted. Summing up these results it can be said that after salting there is an osmotic diffusion of water, from the curd tending to dilute all constitutents of the whey, while there is also a membrane effect which tends to increase the concentration of anions and decrease that of cations.

We can explain these results if we imagine a curd particle as being surrounded by a membrane permeable to all ions but protein ions, we obtain the conditions necessary for a Donnan equilibrium. It may be shown, theoretically, for such a case that the addition of an electrolyte such as sodium chloride will produce a rise in concentrations of cations in the outer liquid. The outward diffusion of water may be another result of this equilibrium or may be a simple osmotic diffusion due to the slow rate of diffusion of salt into the curd. The concentration of sodium chloride inside and outside the particle may be brought into equilibrium either by an outward diffusion of water or by an inward diffusion of sodium chloride. Until equilibrium is established, which may require some hours, both forms of diffusion will probably take place. Much of the water which diffuses out will escape as whey and will contain the various whey constituents in a more dilute form than prior to salting.

The Donnan equilibrium will have an important effect in determining the relation of the lactic acid in the curd to the whey acidity at all stages of the process. Any factors affecting this equilibrium will thus alter the significance of the whey acidities as a means of determining the extent of lactose fermentation in the curd. Among the factors controlling the equilibrium is the ionisation of the curd protein. This will be affected by the pH and also probably by other factors such as heat and rennet action, which alter the nature of the protein. It seems possible that in this equilibrium lies

[68] Schneidewind, *et al.*, *Landwirt. Jahrb. Schweiz.*, 1906, 35, 911.
[69] Falk and Winslow, *Journ. Biol. Chem.*, 1918, 33, 453.
[70] Robbins, *Amer. Journ. Bot.*, 1916, 3, 234.
[71] Krueger and West, *Journ. Gen. Physiol.*, 1936 19, 75.
[72] McDowall and Dolby, *Journ. Dairy Research*, 1936, 7, 156.

the key to the anomalous acidity readings mentioned by McDowall and Dolby.[72]

MEMBRANE EQUILIBRIA IN SOIL PHYSICS.

Lemmermann and Wiesmann[73] have found that the plants are better able to assimilate phosphoric acid from the soil, if the soil contains silicic acid, probably in colloidal form. Stollenwerk[73] working with Naaki observed that the manures in the form of potassium and phosphoric acid, can be used more economically when mixed with pure natural silicic acid. Silicic acid, SiO_2, which is negatively charged was of great help to the plants in the assimilation of food, whereas the positively charged iron hydroxide, $Fe(OH)_3$, hindered the assimilation of food. Stollenwerk[73] also carried out some experiments on marshy soil, making use of the solubility of the silicic acid in humic acid. It appears that the presence of the colloidal substances in the soils leads to a large yield, *i.e.*, to a better assimilation of food. Applying the Donnan equilibrium to the process we see that the colloids which are undissociated and non-diffusible help the dissociated substances to diffuse into the plant. Stollenwerk's experiments also appear to indicate that singly charged cations are more easily taken in the plant in the presence of colloids than the doubly charged cations.

Similar experiments carried out by Behrens and Robertson[74] show that H ions are exchanged when neutral salts react with acid sphagnum peat. An equivalent entrance of the cation into the peat does not take place in this reaction. In some cases there is an increase in the cation concentration of the salt solution, in other cases there is an increase in the anion concentration. The influence of the concentration and the nature of the cations and anions upon the reaction suggested that the exchange might be explained on the basis of the establishment of Donnan equilibrium between the neutral salt solution and the acid peat.

COLLOIDAL PHENOMENA IN PLANTS

Colloidal systems involve small divisions of matter which expose large surfaces. The particles are, however, many times larger than the molecules so that ordinary molecular and ionic chemical reactions of the dissolved substances, are largely replaced by physical and chemical reactions dependent upon surface forces. A liquid colloidal system is a sol and a solid or a semisolid system a gel. The protoplasm of plants consists of colloidal systems varying from emulsions (sols) to moderately stiff gels. The solid substances of protoplasm proteins, dextrins, gums, etc., are characterised by the readiness with which they form colloidal systems in water.

The property[22] of not being permeable to substances dissolved in the cell sap is preserved by protoplasm only as long as it is alive. As soon as protoplasm dies, it loses its impermeability, and the substances dissolved in the cell sap diffuse out. The loss of impermeability by the killed cell results from changes in the state of the colloids of the protoplasm. From the condition of a sol they are transferred to that of a gel, the degree of their dispersion decreases, and their micellæ form irregular aggregates, between which, canals readily accessible to water and solutions are opened. This phenomena is called coagulation. The coagulation of protoplasm may be brought about by different causes, such as high temperatures, poisons, salts of heavy metal, acids, alkalies, as well as by an excessive withdrawal of water or even by mechanical pressure. In all cases coagulation leads to the death of the protoplasm. The phenomena of coagulation is, however, peculiar not only to protoplasm and albuminous substances in general, but also to other colloids of emulsoid and suspensoid character.

In many instances protoplasm may be dried to a state of complete air desiccation when usually 10 to 12 p. c. of the so-called hygroscopic moisture remains without losing its vitality, *i.e.*, the faculty of returning to the sol condition. Thus seeds which in the ripening lose all free water and being air dry simultaneously suspend all vital processes, when moistened, once more return to activity. The same is true of many cryptograms, such as mosses, lichens, and some ferns. Not only their organs of reproduction but the whole thallus of these plants may be reduced to an air-dry condition. They return to activity when moistened. In such a dried protoplasm, therefore, some processes must be going on which alter the dispostion of its particles. When stored for a very long period, dry seeds lose their power of geminating. Under similar conditions dried cryptograms lose their capacity of returning to

[73] W. Stollenwerk, *Zeit. Anorg. All. Chem.*, 1937, **231**, 192.

[74] Behrens and Robertson, *Zeit. Pflanzenernähr. Düngung Bodenkunde*, 1931, **23 A**, 50.

life. Similar coagulation is observed when photographic plates are kept for a long time, their emulsion gradually becomes more and more coarse-grained and the plates lose their sensitivity to light.

All biological processes are characterised by life and the living cell is really a physico-chemical transformer which assimilates various substances and maintains itself in a state of dynamical equilibrium. Naturally many of the problems involving the application of colloidal physics and chemistry to protoplasma and plant physiology are but imperfectly understood. Still it has been possible to explain a large number of biological processes, at least qualitatively, by the application of Donnan equilibrium. Donnan considers an active living cell. In such a cell assimilation of substances oxidation and decomposition are taking place. The products of decomposition are excreted from the cell. In short the cell is continually changing its state. Now let us suppose that all the processes in the cell are stopped only for an instant. We are supposing that the cell is momentarily dead. To such a cell we can apply the laws of thermodynamics. Actually, however, the cell is continuously working. Our procedure in applying the laws of thermodynamics to the living cells is thus similar to the principle of virtual work.

The most essential facts about a living cell[75] are (*a*) its power of specific reproduction and repair, (*b*) its capacity for apparently purposive response and (*c*) its continual exchange of materials and energy. We know of no living organisms which remain indefinitely in a state of equilibrium without the liberation of energy. Life, in fact, is a self-perpetuating series of events : if the continuity of these events be broken by depriving them for a time of energy, their normal progress may be completely altered or prevented. We shall close this article by saying with Donnan,[76] 'Physical chemists were quite prepared to deal with stationary states—and have often done so—and would drop no tears if a rather naive thermodynamical treatment did not provide a complete explanation'.

[75] A. V. Hill, *Trans. Farad. Soc.*, 1930, **26**, 667.

[76] F. G. Donnan, *ibid.*, 1930, **26**, 675.

Received June 26, 1938.

An Automobile Factory in India.

AT the recent conference of the Congress Ministers for Industries held in New Delhi, Sir M. Visvesvaraya, who attended the meeting by special invitation, presented his important scheme for the manufacture of automobiles in India. India, in 1937, imported 16,036 cars and 13,046 commercial trucks, totalling 29,082 vehicles whose value is estimated at 8 crores. This is one of the 'Key' industries which would pave the way for the manufacture of aeroplanes and armaments, so essential for the country's defence.

The scheme provides for the production of 10,000 cars and 5,000 trucks when the plant attains its maximum capacity. In the early stages, however, it is considered economical to import 30 per cent. of the special parts. 18 to 24 months would be required to put the factory into operation. In the first year, the factory will devote itself to assembling imported parts, some of which will be locally manufactured in the second year, and in the third year, the factory is expected to attain its full size and to manufacture the scheduled number of cars.

150 Lakhs is the proposed capital on which a 20 per cent. return is expected. The Government of India's unstinted support by way of a high protective tariff and generous patronage, is essential for the promotion of the industry. Other progressive governments in the West have allowed similar concessions, the import tariff levied in those countries ranging from 50 to 80 per cent.

The creation of an Automobile Industry in the country necessarily leads to the establishment of several other specialised industries. The car has some 2,000 separate parts and these are provided by the special factories. The Volvo Company of Sweden which manufactured a little over 6,000 cars in 1937, had contracts with 100 Swedish firms for the supply of parts. In India, this industry will use local steel and various other raw materials. It will thus help to develop mechanical skill of the highest order among Indian workmen. It will give employment to technically skilled young men. A factory like this established in the country will develop in our engineers and experts, capacity to design and operate high class machine industries of every kind including locomotives and aeroplanes.

Mr. D. N. Wadia.

MR. D. N. WADIA retires in the last week of October, as Officiating Superintendent of the Geological Survey of India, which organisation he served with conspicuous ability and distinction for a period of 17½ years.

He belongs to the band of pioneer Indian scientists who were self-made in the sense that they taught themselves the intricacies of the science they professed and rose to eminence through devotion to work. Hailing from Gujarat, Mr. Wadia graduated from the Bombay University and joined the teaching staff of the Prince of Wales College, Jammu, where he was Professor of Geology (and latterly Principal) for a period of 13 years. After the War, in 1921, he left the placid academic atmosphere of the College and joined the Geological Survey at the request of Sir Thomas Holland who was then the Member in charge of Industries in the Governor-General's Executive Council.

Indian geology is the richer for his joining the official Survey of the country, for his work has brought to light the structure and tectonics of the North-West Himalaya in Kashmir, Gilgit and Hazara. The elucidation of the geology of a large part of Kashmir including Poonch, of the Nanga Parbat area and of the remarkable syntaxis of the North-West Himalaya—to mention only the high lights of his work—will ever stand to the credit of this scientist. In these pioneering studies, Mr. Wadia has covered an area well nigh 12,000 sq. miles in extent of difficult mountainous country between the Potwar Plateau of the Punjab and the snow-clad Zanskar Range of the Central Himalaya.

In 1919 appeared the first edition of his *Geology of India for Students*. In spite of the technical jargon that is inevitable in a work of this nature, this well-known manual is an eminently readable and fine piece of scientific writing with abiding literary qualities. It has trained a whole generation of Indian students in the complicated stratigraphy of this country and has worthily taken the place of the official 'Manual' by R. D. Oldham. A completely revised third edition of this work is now in the press and is expected to be published within the next few weeks.

While in Jammu, Mr. Wadia suffered a bereavement in the loss of his only child. But he found solace in the company of his wife, a lady of great charm, simplicity and generous impulses. She used always to accompany him in the field and share the difficulties of camp life. But, four years ago, he was denied even this solace when Mrs. Wadia suddenly took ill and died in camp, far away from the reach of friends and of medical help. He has borne this irreparable loss bravely and maintained his characteristic calm; none but his more intimate friends know of the suffering which these bereavements have inflicted on him.

Mr. Wadia is so well known in the scientific circles not only of this country but also abroad, that it is superfluous to dilate on his personal qualities. His great devotion to science, his wide cultural interests, his simplicity, helpful disposition and quiet dignity have won him high regard from all who have come into contact with him. He is retiring from service full of academic honours. He is a founder member of the National Institute of Sciences and the Indian Academy of Sciences; a Fellow of the Royal Asiatic Society of Bengal and of the Geological and Geographical Societies of London. He was President of the Geological, Mining and Metallurgical Society of India for the years 1936 to 1938. His services to Indian Geology have been recognised fully by his scientific colleagues who elected him President of the Geology Section of the Indian Science Congress in 1921 and again for the Jubilee session in 1938.

It is with great pleasure that we have heard that the Government of Ceylon has invited him to be their Government Geologist after he retires from service in India. We wish him godspeed in his new work and offer him the best wishes of the scientific world in India for a long life of activity in his retirement.

LETTERS TO THE EDITOR.

The Earliest Solution of the Biquadratic.

The oldest complete solution of the biquadratic is attributed to Ferrari (1522–65). He is supposed to have solved the equation $x^4 + 6x^2 - 60x + 36 = 0$, proposed as a challenge to mathematicians of his time. The historians[1] of mathematics have been for some time familiar with a solution of a biquadratic by Bhaskara (1150 A.D.), an Indian mathematician. But the principle of his method hidden away in a numerical example deserves to be made explicit. Bhaskara solves

$$x^4 - 2x^2 - 400x = 9999$$

by adding to both sides $4x^2 + 400x + 1$ so as to make them perfect squares. This method can be easily generalised thus:

Suppose $x^4 + qx^2 + rx = s$.

Add to both sides $ax^2 - rx + b$ and choose a, b so that both sides may be perfect squares.

Then, we have

$x^4 + (a + q)x^2 + b = ax^2 - rx + (s + b)$

and the conditions to be satisfied by a, b are

$$(a + q)^2 = 4b,\ r^2 = 4a(s + b).$$

Bhaskara has guessed a and b; but we may eliminate b and get a as a root of the *cubic*

$$a^3 + 2a^2q + a(q^2 + 4s) - r^2 = 0$$

exactly the same as the one due to Descartes (1637). The roots of the biquadratic are obtained by solving

$$x^2 + \frac{a+q}{2} = \pm \sqrt{a}\left(x - \frac{r}{2a}\right).$$

So far as we know, Bhaskara's is the earliest attempt at the solution of the biquadratic and is in line with the later solutions of Ferrari, Vieta and Descartes, though, of course, the *cubic* was not there. At a period when even the negative root was admitted with great hesitancy, it is no wonder that imaginary roots should have been regarded as spurious and unfit to mix with the other numbers. Bhaskara therefore naturally recognised only the real positive root of his biquadratic and did not think of the others.

A. A. Krishnaswamy Ayyangar.

Maharaja's College,
Mysore,
September 12, 1938.

[1] *History of Hindu Mathematics*, Part II, by B. Datta and A. N. Singh. (Motilal Banarsi Das, Lahore, 1938.)

The Magnetic Susceptibility of Dilute Sodium Amalgams.

The magnetic susceptibility of dilute sodium amalgams has been studied by the Curie method. Mercury and sodium were both distilled in vacuum and the amalgams prepared, were transferred to small pyrex bulbs which were sealed in vacuum. Since the entire work was done in the absence of air, there was no possibility of the results being vitiated by oxidation or absorption of impurities by the amalgam. Values of the susceptibility were obtained at five

field strengths and their average taken. Water was taken as the standard substance and its susceptibility was assumed to be -0.720 (in 10^{-6} units) at room temperature (30° C). The concentration of sodium in the amalgam was determined by treating it with water and estimating the hydroxide obtained by titration against standard hydrochloric acid.

The values obtained with pure mercury and pure sodium are given below. These values are in satisfactory agreement with those of other authors, also given below for comparison.

Mercury.

Authors.	χ
Owen[1]	-0.184
Davis and Keeping[2]	-0.189
Vogt[3]	-0.168
Bates and Tai[4]	-0.1675
Bates and Baker[5]	-0.1675 (at 30° C.)
Bhatnagar and Nevgi[6] (for purified and distilled mercury)	-0.157
Bhatnagar and Nevgi[6] (for mercury obtained from extra-pure compounds)	-0.172 (Average)
Author	-0.166

Sodium.

Authors	χ
Honda[7] and Owen[1]	$+0.51$
Sucksmith[8]	$+0.59$
McLennan, Ruedy and Cohen[9]	$+0.59$
Lane[10]	$+0.65$
Author	$+0.57$

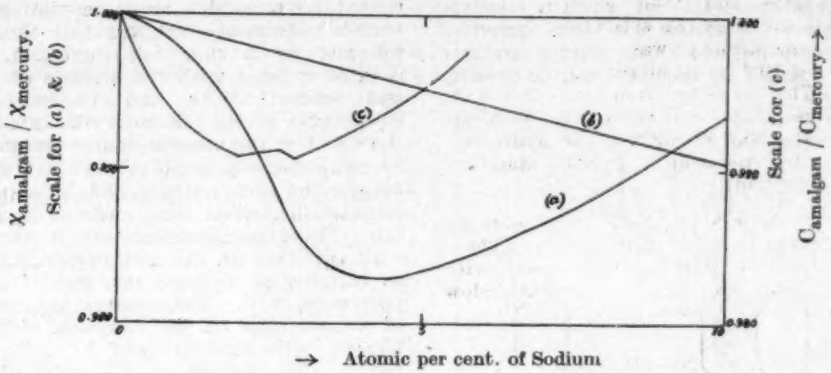
Twenty dilute amalgams were studied having concentrations below 1·3 per cent. by weight of sodium. The variation of the susceptibility with concentration is shown by curve (*a*) in the figure. The concentration plotted along the X-axis is expressed in atomic per cent. of sodium in the amalgam. It is found that as the concentration of sodium is increased, the diamagnetic susceptibility decreases, at first slowly and then more rapidly. A flat minimum is obtained at a concentration of about 4½ atomic per cent. of sodium. At larger concentrations, the diamagnetic susceptibility of the amalgam increases gradually.

The straight line graph in the figure represents the concentration-susceptibility variation in accordance with the law of additivity. Comparison of the two curves shows that there is considerable departure from this law.

When minute quantities of sodium are added to the amalgam, the sodium goes into solution. W. Kerp and co-workers[11] found for the percentage solubility of sodium in mercury the values of 0·65 at 25° C. and 0·86 at 65° C. This corresponds to an atomic percentage of 5·5 at room temperature. In the graph, the minimum susceptibility is obtained at a concentration very near this value. It is possible, therefore, that the initial fall in the diamagnetic susceptibility is due to the solution of sodium in the mercury.

When larger quantities of sodium are added to mercury, it is likely that solid compounds of sodium and mercury are formed. Several such compounds are supposed to exist and some of them have been claimed to have been isolated. In such cases it is possible that the paramagnetic contribution of the free electrons in the atoms disappears and the diamagnetic susceptibility increases. These compounds of mercury separate and float on the surface of mercury in the form of pasty masses. In our experiments, we found that while at concentrations below about 5 atomic per cent. different samples taken from the same stock amalgam gave nearly identical values, at concentrations above 5 per cent., large differences were obtained. This may be attributed to the non-homogeneity of the amalgam with comparatively richer sodium content.

In this connection it may be pointed out that the electrical conductivity of dilute sodium amalgams, at first decreases with increase of sodium content, reaches a minimum and then increases as has been shown by Davies and Evans.[12] Curve (*c*) in the figure has been adapted from their results. The minimum point of this curve, however, occurs between 2 and 3 atomic



per cent. (*c* in the figure stands for conductivity.)

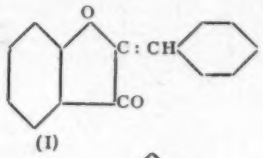
Investigations on dilute amalgams of the other alkali elements are in progress. Full data will be published elsewhere.

S. Aravamuthachari.
Annamalai University,
Annamalainagar,
October 5, 1938.

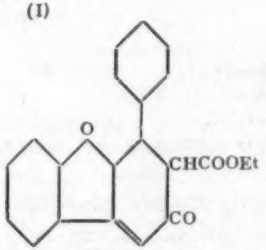
[1] *Ann. der. Phys.*, 1912, **37**, 657.
[2] *Phil. Mag.*, 1929, **7**, 145.
[3] *Ann. der Phys.*, 1932, **14**, 1; 1935, **21**, 791.
[4] *Proc. Phys. Soc.*, 1936, **48**, 795.
[5] *Ibid.*, 1938, **50**, 409.
[6] *Curr. Sci.*, **6**, 53.
[7] *Ann. der Phys.*, 1910, **32**, 1027.
[8] *Phil. Mag.*, 1926, **2**, 21.
[9] *Proc. Roy. Soc.*, 1927, **116**, 468.
[10] *Phil. Mag.*, 7th Series, 1929, **8** (1), 345.
[11] *Mellor's Treatise*, **4**, 1010.
[12] *Phil. Mag.*, 1930, **10**, 569.

Benzylidene-Coumaranones considered as Chalkones.

Chalkones which contain the group $-CO-CH=CH-$, undergo as is well known a variety of condensation reactions with acetoacetic ester and other compounds containing the reactive methylene group next to a keto-group. We have now found that benzylidene-coumaranones (I) behave like chalkones and condense with acetoacetic ester to give compounds of the type (II) and also with desoxybenzoin, cyclohexanone and flavanone. It is probable that benzylidene-flavanones which also contain the group $-CO-CH=CH-$ will react similarly to give a variety of new ring systems.



(I)



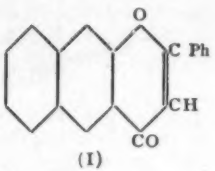
(II)

T. B. Panse.
T. S. Wheeler.
Royal Institute of Science,
Bombay,
September 19, 1938.

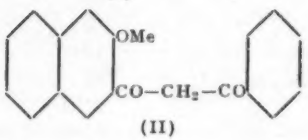
Synthesis of Linear Naphthaflavone.

Both the angular *α*- and *β*-naphthaflavones have long been known; the synthesis of linear naphthaflavone (I) has now been achieved, by condensing methyl 2-methoxy-3-naphthoate with acetophenone with finely divided sodium in presence of dry ether, and heating the resulting benzoyl-2-methoxy-3-naphthoylmethane (II) with hydrogen bromide in acetic acid until alcoholic ferric chloride no longer produces a colour. (I) with sodium ethoxide[1] gives 2 hydroxy-3-

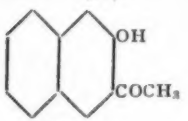
acetonaphthone (III) for which a relatively convenient synthesis is thus provided. Compounds in which the phenyl group in (I) is replaced by naphthyl can be obtained similarly.



(I)



(II)



(III)

V. V. Virkar.
T. S. Wheeler.

Royal Institute of Science,
Bombay,
September 21, 1938.

[1] Kostanecki and Ludwig, *Ber.*, 1898, **31**, 2951.

The Electric Double Layer, an Effective Potential Barrier for the Accumulation of the Solute at Surfaces of Solutions of Capillary-Active Electrolytes.

When the surface of an aqueous solution of a capillary-active electrolyte is allowed to age, an oriented adsorption film is developed in which the ionised group of the capillary-active ion is pointing towards the solution and the hydrophobic part is projecting into the free space above. This brings about a redistribution of the ions in solution giving rise to a diffuse electric double layer on the solution side of the interface. Simple calculations show that the electric double layer presents an effective potential barrier for further accumulation of the capillary-active ions, especially when the adsorption film is of the gaseous type. Thus, when the surface of a solution of a paraffin-chain salt (giving rise to a gaseous adsorption film) is allowed to age, there should be a sudden surge in the fall of surface tension at start and this should be followed by a slow fall thereafter. This is in accordance with the findings of Adam and Schute.[1] With the capillary-active electrolytes giving rise to a condensed film, the effect of the electric double layer would be comparatively small (though not negligible) in the initial stages and become very considerable when the surface is nearly full. These conclusions are also in harmony[2] with the data on the rate of accumulation at surfaces of aqueous solutions of benzopurpurine 10 B. The accelerating influence of neutral salts on the variation of surface tension with time, noticed by Adam and Schute also receives an adequate interpretation on the basis of this concept. The slowing down of the accumulation with increase in pH, in the case of benzopurpurine 10 B solutions[2] is also explained. The details of these investigations, as well as a discussion of the denudation of the solution just below the surface layer observed by McBain[3] will shortly be published.

K. S. Gururaja Doss.

Department of Chemistry,
Central College,
Bangalore,
September 15, 1938.

[1] Adam and Schute, *Trans. Farad. Soc.*, 1938, **34**, 758.
[2] Doss, *Kolloid Z.*, 1938, **84**, 138.
[3] McBain, *Nature*, 1936, **137**, 659.

Bromination of Aliphatic Ketones.

Direct bromination of ketones in the absence of catalysers with excess of bromine does not seem to have been attempted except in a few cases like acetone and diacetyl. Several ketones were brominated by us by the general method of keeping the ketone in contact with excess of bromine for four days. Practically in all the cases the reaction is accelerated, after the absorption of a small portion of the bromine added which requires in some cases 30–45 minutes. The reaction mixture is cooled from time to time by means of cold water. After four days about 300 c.c. of water are added to the reaction mixture and the excess of bromine is removed by blowing air into the mixture. The resulting product, if liquid,

TABLE I.

No.	Name of the ketone	Bromo-ketone	Yield (purified product) %	M.P. °C.	B.P. at 4 mm. °C.
1	Acetone $CH_3CO.CH_3$	$C_3H.O.Br_5$	28	72–73	
2	Methylethylketone $CH_3CO.CH_2CH_3$	$C_4H_4O.Br_4$	44	54	
3	Diethylketone $C_2H_5CO.C_2H_5$	$C_5H_7O.Br_3$	81	..	90–93
4	Dipropylketone $C_3H_7CO.C_3H_7$	$C_7H_{11}O.Br_3$	78	..	120–123
5	N-dibutylketone $C_4H_9CO.C_4H_9$	$C_9H_{15}O.Br_3$	65	..	121–123
6	*Iso*-dibutylketone $(CH_3)_2CH.CH_2$ > CO, $(CH_3)_2CH.CH_2$ > CO	$C_9H_{15}O.Br_3$	70	..	120–132
7	Capron $(CH)_3(CH_2)_4$ > CO, $CH_3\ (CH_2)_4$ > CO	$C_{11}H_{19}O.Br_3$	65	..	162–165
8	Diacetyl $CH_3CO.CO.CH_3$	$C_4H_2O.Br_4$	60	94	
9	Acetonyl-acetone $CH_3COCH_2.CH_2COCH_3$	$C_6H_2O.Br_6$		181	
10	Pinacoline $CH_3CO.C\ (CH_3)_3$	$C_6H_{10}O.Br_2$	66	69	

is distilled under reduced pressure and if solid, is fractionally crystallised from ether. The analyses of the bromo-compounds were in good agreement and some of them have not been described before. They have a penetrating odour attacking the eyes and are soluble in the common organic solvents. The quantity of bromine taken should be in excess for the elimination of every hydrogen atom in the ketone as hydrobromic acid and replacement of the hydrogens so removed by bromine. The results obtained have been recorded in Table I.

It can be seen that irrespective of the length of the chain and the number of hydrogen atoms, only a few of the hydrogen atoms are replaced by bromine. With ketones containing more than one carbonyl group the number of hydrogen atoms replaced by bromine is much greater. There appears to be an empirical relationship between the number of hydrogen atoms that are replaced by bromine, and the hydrogen atoms, adjacent to the carbonyl groups. The number of hydrogen atoms replaced by bromine is equal to the number of hydrogen atoms adjacent to carbonyl groups less as many as there are carbonyl groups. We are testing this relationship with a few more ketones.

S. V. SHAH.
D. G. PISHAWIKAR.

Department of Chemistry,
Rajaram College,
Kolhapur,
July 16, 1938.

"Knife Cut" at the Base of the Peduncle of Sorghum.

J. P. MARTIN[1] describing abnormal growths of sugarcane refers to the occurrence in association with stem galls of "Knife Cut"—an extremely interesting symmetrical cut which usually occurs on the internode

immediately above the bud. This abnormal condition, he states, is often found below the growing point on the very young internodes.

A rare and interesting instance of a "Knife Cut" has been met with in Sorghum. This occurred in one of the lines of Sudan grass bred for fodder value and got down from the All-Union Research Institute of Plant Breeding—Section of Forage Plants, Odessa, U.S.S.R. In this line, from a third to a fourth of the population gave plants with knife cuts at the base of the peduncle. These cuts appear above the bud and root zone and on the side away from the leaf-bud and at the intercalary growing zone which is always the softest and therefore the weakest spot in sorghum stalks. In high winds it is here that the heads snap. Whenever knife cuts occurred, the heads had not emerged full and clear out of the leaf-sheath. The tip of the head or a portion thereof was always stuck up and held fast within the grip of the inrolled apex of the ultimate leaf-sheath—the sheath bearing the flag. The cause of the cut is obviously the arrest in the free emergence of the panicle.

In the breeding of Sudan grass for better fodder purposes, it looks as if some sweet sorghum blood, probably *S. bicolor* in origin, has been infused into this grass. The characteristic of Sudan grass is a loose sparse-flowered ear-head, a very long peduncle, a thin leaf-sheath and a slight overlap of the leaf-sheath flaps and consequently a fairly loose hold on the peduncle. A study of a few sweet sorghums with *S. bicolor* blood shows that the heads are relatively compact, the emergence fair, the leaf-sheaths thick and tough with a 1½ overlap on the stalk. An examination of the leaf-sheaths in this "Knife Cut" family shows that the average thickness of the dry leaf-sheath is 1·2 mm. as against 0·5 mm. of the leaf-sheath of pure Sudan grass. It looks therefore that in this line, there is a misfit between the leaf-sheath and earhead equipment, finding expression in the mutilation under record. Like goose necking, this character manifests only under optimum conditions. When the earhead manages to escape the impediments in its emergence, the cut does not appear.

A number of measurements were taken of the lengths of leaf-sheaths and of the peduncles in plants with and without the knife cut. In the normal plants the average length of ten leaf-sheaths is 27·4 cm. and the average length of peduncles up to the base of the earhead is 31·0 cm. In plants with the knife cut, the leaf-sheath length is similar to the normal leaf-sheath length, but the peduncle length is only 10·2 cm. ranging from 3 to 22 cm. At the longer end, the knife cut is shallow and at the narrow end, the cut gapes out till it makes very nearly a right-angular dent (see photograph). With the heads stuck up in the

"Knife Cut" at the base of the Peduncle of Sorghum.

top cone of the leaf-sheath and the intercalary growth very vigorous, the stalk snaps at the weakest spot and exposes the cut base through a lightly overlapping leaf-sheath base. There are varieties with poor emergence and with heads stuck up in their boot; but no knife cut accompanies this condition as the general emergence keeps pace with the intercalary growth vigour. But with the wild blood of Sudan grass the heads have to be aloft and the inter-

calary growth has therefore to be extremely vigorous.

This unlooked for consequence is a poignant reminder to the sorghum breeder about the possible repercussions of an otherwise sound breeding programme.

G. N. Rangaswami Ayyangar.
B. W. X. Ponnaiya.

Agricultural Research Institute,
Coimbatore,
September 20, 1938.

[1] *Proc. Fourth Cong. Int. Soc. Sugarcane Technology*, 1932, Bull. 73, 19.

The Occurrence of Hollow Grains and Hollow Peduncles in Sorghum.

Most of the members of the Graminæ are characterised by having hollow stems. A tubular internodal equipment affords maximum strength with minimum material. Most of the wild sorghums have pithy lower internodes but their peduncles are not entirely pithy. In the top of the peduncle up to a length of about 5 cm. below the base of the panicle the internodes are hollow. There is a tendency for slightly hollow peduncle tops to occur in the Caffra and in the Nervosa sub-series[1] of sorghum. In the cultivated grain sorghums all the internodes and the peduncles are entirely pithy. Sorghum is a cereal that has been evolved both for grain and for fodder and hollow internodes would be a misfit in the scheme of their evolution.

An examination of the foreign grain sorghums under study reveals the fact that varieties from China belonging to the group *S. nervosum* are hollow in the tops of their peduncles; so also the African grain sorghums belonging to the group *S. nigricans* from Tanganyika, N. Rhodesia and Belgian Congo. These two groups of sorghum have grains that are soft when compared with the hard grains of *S. durra* and the flinty grains of *S. cernuum*. Of the two groups, the *nigricans* group is the softer. In this group of sorghum (in which the grains are mostly chalky[2]) there is a hollow in the centre of the grain at the dough stage. This hollow is clear in one particular family, *viz.*, A.S. 4660, which has fairly big grains. In this, the peduncle also showed the hollow fairly well. Longitudinal and transverse sections of these hollow grains and hollow peduncles are given in the accompanying photographs. The hollow grains are like the normal ones till the milky stage. When they reach

Transverse and longitudinal sections of the Grain and Peduncle in *Sorghum nigricans*. Family No. A. S. 4660.

the dough stage the starch is not formed in the centre of the grain but leaves it hollow. As the grains ripen, the top of the grain wrinkles and in some cases a slight pitting also occurs. The hollow inside the grain ranges from a minute cavity to one 3 mm. in length. As the peduncles of the grain sorghums are thick, the hollow is often seen over the entire length of the peduncle.

The concurrent occurrence of this hollow in both the peduncle and in the grain of some of the soft chalky grained sorghums from Africa and China is very interesting.

G. N. Rangaswami Ayyangar.
V. Narayanan.

Millets Breeding Station,
Coimbatore,
September 26, 1938.

[1] Snowden, *The Cultivated Races of Sorghum*, 1936.
[2] *Ind. Jour. Agric. Sci.*, 1934, 4, 96.

REVIEWS.

The Evolution of Physics. By Albert Einstein and Leopald Infeld. (The University Press, Cambridge), 1938. Pp. 319. Price 8*s*. 6*d*.

This book is a welcome addition to that class of scientific literature which has for its aim the presentation of recent physical concepts to those who are not specialists in physics but who are nevertheless anxious to understand the advances in scientific thought. In the words of the authors their object in writing the book has been "to sketch in broad outline the attempts of the human mind to find a connection between the world of ideas and the world of phenomena". A perusal of the book makes it clear that they have succeeded in this attempt. The book is particularly free from the usual defects of books intended to popularise science; for instance, there is not a single misleading analogy in the whole book. One who wants to benefit by reading it must take pains and provided he does take pains there is nothing too technical in it that would stand in the way of his understanding the topics dealt with in the several chapters. The book is divided into four chapters. The first is styled "The Rise of the Mechanical View". Here we have a clear presentation of what may be called the older classical physics. In the second chapter with the heading, "The Decline of the Mechanical View", the reader is introduced to the electric and magnetic field theories and the wave theory of light. In the earlier part of the third chapter there is treated the field theory of electric phenomena, the result of the work of Faraday, Maxwell and Herts. In the latter half of this chapter both the special and general theories of relativity are treated in a charmingly interesting and clear manner. Chapter four under the name "Quanta" contains an account of the more recent aspects of physical theory.

The aim of theoretical physics has been described by the authors as follows: "We want the observed facts to follow logically from our concept of reality. Without the belief that it is possible to grasp the reality with our theoretical constructions, without the belief in the inner harmony of our world, there could be no science. This belief is and always will remain the fundamental motive for all scientific creation." The treatment of the subject has been so planned as to bring home to the reader that this aim runs throughout the evolutionary history of theoretical physics.

We have no hesitation in heartily recommending the book to the general reader who is anxious to get an insight into modern theories in physics. B. V.

The Fine Structure of Matter. By C. H. Douglas Clark. Vol. II, Part III. *The Quantum Theory and Line Spectra.* (Chapman & Hall, Ltd., London), 1938. Pp. lxxii + 459–643. Price 15*s*. net.

This is Part III of the second volume of a comprehensive treatise on atomic and molecular structure. It is the object of the author to bring together the various fields of research which have shed light on the structure of matter so that by their juxtaposition a more comprehensive outlook may be possible. Accordingly, he deals with crystal structure, electric moments, atomic and molecular spectra and the Raman effect, each of which is a vast field of specialised study. As the author says, "an individual author is apt to regard his own point of view as capable of explaining all the results of experiment, and a wider outlook is necessary". So "the present work has accumulated together in one place many of the facts which should be taken into account, references being supplied where the treatment is not full". The part before us deals with atomic spectra, with Bohr's theory and the vector model serving as the bases for the interpretation. The treatment is mostly descriptive and qualitative, some necessary mathematical derivations being relegated to an Appendix. The author is naturally fascinated by the music of numbers which permeates spectroscopy and some space is devoted to exhibit a large number of numerical relationships, particularly between the various energy units usual in this part of the subject. The exposition of Hund's theory of spectral terms is lucid and adequate. The experimental results obtained by the

analysis of the spectra of the elements in various stages of ionisation are set forth in detail. The whole existing literature up to the end of 1935 has been thoroughly combed and the extensive lists of references will be of great use to workers in the field. The discussion of the connection between the ground states of atoms and valency is fresh and interesting. The book is a very useful source of information to all those interested in knowing the results which have been obtained in various fields of research, without any great need of mathematical details.

We may mention a few oversights here and there. On p. 485 a and b are called major and minor axes instead of semi-major and semi-minor axes respectively. It is also there stated that for $n = 3$, $k = 1$ corresponds to a circular orbit and $k = 3$ corresponds to the most eccentric ellipse while the reverse is true. On p. 527 we find Russell, Shenstone and Taylor for Russell, Shenstone and Turner. On p. 546 it is stated that the separation of F terms is less than D terms, and that of D terms less than for F terms, where the last F should be P. There are also some misprints on pp. 491, 528, 531, 538, 610 and 638. In connection with Burger and Dorgelo's summation rule for intensities of spectral lines it would have been better if Sommerfeld and Hönl's formulæ were also given. These minor matters do not in the least detract from the merit of the book which may be recommended to all desiring a full account of the results achieved in the field dealt with.

T. S. S.

Elementary Practical Physics. By Newton Henry Black and Harvey Nathaniel Davis. (New York: The Macmillan Company), 1938. Pp. viii + 710. Price 8*s*. 6*d*.

This is not a text-book of laboratory experiments but a book which deals with the Physics met with in practical everyday life. This is the type of book we should like to see in the hands of every S.S.L.C. student to correct a bias towards cramming so easily possible in our examination-ridden country, where what a student studies in school has so little connection with his later life. The book starts with everyday appliances and builds up the principles of Physics by an appeal to the student's experience of these appliances. It succeeds admirably in arousing the interest of the student and succeeds also in making him understand the essential principles of the subject. Though the standard of mathematics used is well below the attainments of an S.S.L.C. student, a very useful account of the most modern developments such as atomic structure, Radio, Talkies and Television is brought within his reach. The illustrations simply make one love the book, so numerous and beautiful are they. The problems and questions will surely make the student think, not from the compulsion of an impending examination, but from an inner necessity of satisfying a curiosity aroused in him. The binding will stand the roughest usage. On the whole, the book is admirably suited to give the student an intelligent understanding of his surroundings and may confidently be recommended for use in academic as well as technical courses involving an introduction to the principles of Physics. Some peculiarities in the book, *e.g.*, the use of gravitational units throughout, necessitating such formulæ as $F = \frac{Wv^2}{gr}$ for centrifugal force, or the definitions of specific resistance and electrochemical equivalents, may look rather unfamiliar. The solution of a problem in impact on p. 221 by making use of the principle of conservation of energy may lead to misconceptions. The statement on p. 641 that Sir William Ramsay first discovered helium in the Sun is not quite correct. But these are minor matters which may be overlooked while recommending an excellent book.

T. S. S.

Electron and Nuclear Physics. By J. Barton, Hoag. (Chapman & Hall, Ltd., London), 1938. Pp. 502. Price 20*s*. net.

The present volume is the enlarged edition of the author's *Electron Physics* published in 1929. The book is roughly divided into four parts. The first nine chapters covering 222 pages deal with Electron Physics. The next six chapters covering 132 pages deal with Nuclear Physics. The next four chapters covering 96 pages deal with modern experimental technique of high vacuum, high voltage, small currents and detection of particles and radiation, such as counters and expansion chambers and ionisation chambers. The last part in 9 pages

gives a large number of problems, under each of the 19 chapters.

Simple statements of the experimental facts and physical principles of both the newer and older concepts are recognised as being of great help in bridging the gap between the early study of physics and the specialization of advanced research.

A successful effort has been made to develop the subjects in such a sequence as to avoid reference at any point to discussions which appear later in the book. The early chapters treat of the electron, its charge, mass, wave-length and emission from hot and cold surfaces. These are followed by chapters dealing with electrical phenomena specific to the outer parts of the atom. In succeeding chapters there are discussions of the phenomena involving the nuclei of the atoms, such as positive rays, natural and artificial radioactivity, transmutations, etc. There is unity about the whole book, because many basic relations and experimental techniques are common to several of these fields of study.

A speciality of the book is a detailed description of some basic and important experiments at the end of each chapter. The apparatus has been simplified from the original research form to an extent which avoids the expenditure of too much time or effort, yet permits an insight into actual work.

No student of physics, engaged in advanced studies or research can well be without this excellent book, thoroughly practical but fully equipped with the necessary theoretical background.

B. DASANNACHARYA.

Hurricanes, their Nature and History. By Ivan Ray Tannehill. (Princeton University Press, Princeton, New Jersey, U.S.A.), 1938. Price $ 3·50.

The word "hurricane" is generally used by meteorologists and seamen in two different senses—one to denote any wind of speed of greater than about 65 miles per hour and another to denote the cyclonic storms of certain tropical and subtropical regions of the earth, for example, the South Pacific, South Indian and North Atlantic Oceans. The word is used in the latter sense in this book. In essence, the hurricanes of the West Indian Seas are not different in character from the cyclones of the Indian seas or the typhoons of the China Seas or the baguios of the Philippines. They all come under the general class of "tropical cyclones". Although there are many papers and memoirs on tropicl cyclones, books on the subject are few, two of the best known being Eliot's *Handbook of Cyclonic Storms of the Bay of Bengal* and Cline's *Tropical Cyclones*. A new book dealing in a general way with the whole subject is therefore very welcome. The chief of the Marine Division of the United States Weather Bureau with his exceptionally large experience of cyclone warning work in America has here presented us with an authoritative and lucidly written account of this fascinating subject.

The book may be broadly divided into two parts—the first part dealing with the characteristic phenomena of tropical cyclones, their places of origin, direction and speed of movement, the changes of pressure, wind and rainfall associated with their passage and the nature of warnings issued by the Weather Bureaus for the safety of life and property on sea and land. Cyclones of different parts of the world come under consideration; those of the Indian Seas, being well-known and having been carefully studied for nearly a century, receive a good deal of attention.

Among the most terrible effects of some tropical cyclones is the inundation of low coastal areas or river-basins by the storm-wave which sometimes accompanies the passage of the cyclonic centre from sea to land. The risk of this is greatest in regions where there is an enclosed sea and a rising sea-bed and on occasions when the entry of the storm-centre happens to coincide with a high tide. Many instances of disastrous storm-waves have occurred in the deltaic area round the head of the Bay of Bengal, the most notable one having been associated with Backergunge Cyclone of 1876 when the storm-wave rose to heights of 10 to 40 ft. over the islands and low banks near the mouth of the river Meghna, and caused a loss of life of over 100,000. The author has not been forgetful of the beneficial effects of cyclones—he quotes an estimate of Newham that in the Puerto Rico hurricane of 1899, the total mass of water precipitated as rainfall on

that island alone was about 2,600 million tons. Some of the Bay of Bengal cyclones have been responsible for the distribution of over 40,000 million tons of water over a land area of 125,000 sq. miles!

The scientific study of cyclones began more than 100 years ago. The work done during the last century gave us the essential basic knowledge necessary for issuing useful warnings about their approach. The recent growth of wireless has given the meteorologist more data from sea areas, thus enabling him to improve his forecasts and quickly disseminating the available information. The development of upper air work is gradually adding new and essential data about the changing conditions in the higher levels of the atmosphere. These are very necessary for obtaining a fuller insight into the structure and mechanism of tropical cyclones. Studies of the available upper air data in relation to cyclones are being made in a few countries, including India. The extension of scheduled flying over sea-areas makes it imperative that such studies should be intensified and accelerated. The author has not touched on this aspect of the subject, perhaps, because he feels that the data are yet insufficient.

We offer a hearty welcome to this very readable and well-produced book on what is undoubtedly one of the major phenomena of the earth's atmosphere. K. R. R.

The Observational Approach to Cosmology. By Edwin Hubble. (Clarendon Press, Oxford), 1937. Pp. 68. Price 6s.

It is now generally recognized that the spiral and other extra-galactic nebulæ are in reality stellar systems comparable in many respects to the system of the Milky Way of which our Sun forms a member. Herschel, by means of his star-gauges laid the foundation for the study of the structure of the galactic system and since his time, considerable progress has been made in that direction, so that the general outlines of the system have been determined with a fair amount of certainty. Very little was known about the vast number of extra galactic nebulæ until the beginning of the present century; the nature of the nebulæ and their position in space were more or less subjects of speculation. The pioneer work of Keeler at the Lick Observatory and of Slipher at Flagstaff represent the earliest attempts towards a regular study of these extremely remote objects. Our present knowledge of the nebular system is entirely due to the large telescopes at Mount Wilson and Dr. Hubble's work with these powerful instruments forms the chief contribution to the astounding progress that has been made in the subject during the last two decades.

The present book contains the three Rhodes Memorial Lectures delivered at Oxford by the author in 1936 and summarises from the observer's point of view, the general features of the Universe as revealed by the observational data so far accumulated. The first chapter deals with the several criteria that have been developed, step by step, for estimating distances of nebulæ, ranging from the nearest to those that are at the limits of telescopic vision. An important fact established by the various surveys is the homogeneity in the distribution of the nebulæ, that extends throughout the part of the Universe under reconnaissance. Dr. Hubble considers this to be a significant factor. The region that can be surveyed is about a thousand million light years in diameter, inhabited by about a hundred million nebulæ and this observable region is taken as a fair sample of the Universe.

In the second chapter we have an account of the spectra of nebulæ and of the behaviour of the H and K lines that are found displaced towards the red. Two possible methods of interpretation of these displacements are described; either the red shifts may be taken to be true velocity shifts due to recession or they may not be considered as velocity shifts at all, but may be attributed to some unknown physical principle. A discussion of the inferences leads to widely different pictures of the Universe according to the interpretation given to the phenomenon. The third chapter contains an exposition of the effects of the two alternative assumptions, on the surveys made in the regions of space within reach of our telescopes and their relationship to the concept of a stationary or expanding universe. Dr. Hubble concludes that, from the available data, it is not possible to affirm which of the two pictures more exactly conforms to observations.

The book gives a comprehensive account of the subject from the observational point of view. It is written in a simple lucid style and will be read with the greatest interest by all students of cosmology.

T. P. B.

The Application of Moving Axes Methods to the Geometry of Curves and Surfaces. By Dr. G. S. Mahajani. (Aryabhushan Press, Poona, India), 1937. Pp. 60.

Several geometrical results can be proved by the application of the principles of dynamics and statics. Many of these proofs are quite instructive, but the philosophical principles or foundations underlying them are those of mechanics, not of geometry. In differential geometry, the principle of moving axes is often employed to derive results. Many geometers however fight shy of this method, and prefer the purely geometrical methods. In the present pamphlet, the author applies the principle to work out several standard results and problems of elementary three-dimensional differential geometry. Dr. Mahajani commands a clear style and method of exposition. The student of differential geometry who studies the above problems through the methods advocated will, doubtless, be led into much thought-provoking study that may be of benefit to him and to the subject.

C. N. S.

Agricultural Analysis. By C. H. Wright. (Thomas Murby & Co., London), 1938. Pp. 343. Price 16*s*.

"This book is a laboratory manual giving the details of the methods of analysis of fertilizers, feeding stuffs, milk, milk-products, insecticides and fungicides with references to the sources of information.... It is intended for Agricultural Analysts with limited library facilities, etc." This book arose out of the author's personal needs when working at Fiji and Nigeria. The author has chosen to give for each subject methods recommended by the American Association of Agricultural Chemists, the British Official methods, and those in use at Rothamstead. The work would have been more complete and appeared unbiassed had he at least referred to books on Plant and Agricultural Analysis published in German and other languages. A mention of one such book *Handbuch der Pflanzen Analise* by Klein and co-workers is sufficient to show how the book can be enlarged and improved in future editions. The author has perhaps due to oversight forgotten to mention necessary details like the duration of heating, etc., in certain instances (*e.g.*, estimation of sulphur by Ailken's method). In the estimation of sugars he has omitted even to refer to the Polariscopic method. This is usually the method adopted by most workers in the industry.

The book has been well printed in bold type, which makes the reading all the more pleasent and easy. The binding is in a subdued sombre colour which makes it attractive. The price (16*s*.) is perhaps a little too high for the Indian student but is worth it. It can be recommended without any hesitation to those interested in agricultural analytical chemistry.

N. G. C.

The Intermediate Calculus. By Brij Mohan. (Mohan & Co., Moradabad, India), 1937. Pp. 189. Price Rs. 2–4–0.

The object of the author seems to be to make the book just meet the requirements of a certain examination syllabus. The average student, who wants to pick up the methods of differentiation and integration and apply them to simple examples, will find a helping hand in this book. He will find it elaborately worked out, for instance, that the same result is obtained whether the function $\frac{2x+3}{5x-1}$ is differentiated as a quotient or as a product or as a sum. We wish that the aim of the book was something more than this. It is late enough that text-books on the calculus, however elementary they might be, devoted some space for the definitions of convergent sequences and of continuity and explained them with striking illustrations. The author, who has, without compunction, made so free a use of infinite series to obtain limits, ought to have developed the idea of the limit of a function in a finer and more satisfactory way. One happy feature of the book is that the student is introduced to the notion of the definite integral before he is ushered into the methods of hunting after the primitives of certain functions—a feature rarely to be found in other elementary text-books.

B. S. S.

CENTENARIES

By S. R. Ranganathan, M.A., L.T., F.L.A.
(*University Librarian, Madras*)

Buller, Walter Lawry (1838-1906)

SIR WALTER LAWRY BULLER, a New Zealand ornithologist, was born October 9, 1838, at Nowerk, Bay of Islands. He was educated at Wesley College, Auckland, where he came under the influence of William Swainson, a naturalist.

He specialised in Maori language, conducted a Maori paper, was editor-in-chief of the *Maori messenger* and held several posts connected with Maori administration. He saw active service in the Maori war and went to England (1871) as Secretary to the Agent-General for New Zealand. Having been called to the bar, he practised in the Supreme Court of New Zealand till 1886.

Amidst such a varied career, Buller had been, from an early age, a close observer of the birds of his native land, and had been fired with ambition for making himself an authority on the birds of New Zealand. When he was but thirty-four, his illustrated quarto volume *History of the birds of New Zealand* marked him out as the ornithologist *par excellence* of New Zealand. He also brought out a *Manual of the birds of New Zealand* in 1882.

He had been engaged in field observations even from his youth and the results have been recorded in about 91 papers contributed to the *Transactions* of the New Zealand Institute and a few other learned periodicals. The first paper appeared in the *Zoologist* in 1864 under the title *Notice of the remains of the moa and other birds formerly inhabiting New Zealand*. One of the last papers was, *On a species of crusted penguin from the Auckland Islands* (1899).

In recognition of his services to Natural Science, Buller was elected F.R.S. in 1879 and was decorated with an honorary D.Sc. by the Cambridge University in 1903. He was a large donor to many museums and this brought him further honours from many foreign countries.

By his persistent exploration of the recesses of his country and his continued study of its avifauna, he brought out a second edition of his *History* in 1888 enlarged into two volumes. After a further exploration for seventeen more years, Buller brought out two supplementary volumes. Till a short time before his death, he was dictating from his couch the concluding pages of the supplements " to get them off his mind ".

Buller died at his daughter's residence Pontdail Lodge, Fleet, July 19, 1906.

Oliver, Samuel Pasfield (1838-1907)

SAMUEL PASFIELD OLIVER, an English geographer, was born at Bovinger, Essex, October 30, 1838. After receiving his education at Eton and Woolwich, he received a commission in the royal artillery, April 1, 1859. After seeing service in China, he spent most of his official life in Madagascar and Mauritius.

This gave him an opportunity to his geographical zeal. He spent many months in exploring Madagascar. The history, ethnology, the flora and the fauna engaged his attention. In 1864 the vulcanic eruption on the Island of Reunion gave him the opportunity to record some interesting geological phenomena as well.

In 1867 he joined Captain Pym's exploring expedition to Central America. In 1871–72 he toured in the Near East and this resulted in some first-hand archæological observations in Asia Minor, Greece and Sardinia.

Oliver's varied and versatile interests prevented him from achieving eminence in any one subject. But his books on Madagascar are authoritative. They are *Madagascar and Mealagasy* (1866), *Las Hovas et les autres tribus caracteristique* (1869), *The true story of the French dispute in Madagascar* (1889) and the two volumed *Madagascar* (1886). Some of his contributions appear also in the *Report* of the British Association for the Advancement of Science and the *Proceedings* of the Ethnological Society.

Oliver's health was seriously affected by his explorations in malarial countries. He died at Worthing, July 31, 1907.

ASTRONOMICAL NOTES.

Eclipses.—There will be two eclipses in November 1938; one of these is a total eclipse of the Moon and will take place on November 8, the circumstances of the eclipse being as follows :—

Moon enters umbra	2^h–11^m A.M.
Middle of eclipse	3–56 A.M.
Moon leaves umbra	5–42 A.M.

The times are in Indian Standard Time. The magnitude of the eclipse is 1·36 taking the Moon's diameter as unit. The partial eclipse of the Sun that occurs on November 21–22 will not be visible in India.

Planets during November 1938.—Mercury can be seen low down in the western sky for a short while after sunset. On November 25, it will have greatest elongation from the Sun (21° 51′ E). Venus will be gradually moving westwards and during the latter half of the month, will be too close to the Sun to be conveniently visible. It will be in conjunction with Mercury on November 8 and with the Sun on November 20. Mars will be visible as a morning star, rising about three hours before sunrise.

Both the planets Jupiter and Saturn will continue to be bright objects favourably placed for observation in the early part of the night. Uranus is in the constellation Aries and can be seen near the fifth magnitude star σ Arietis. On November 8 there will be a close conjunction of the planet with the Moon, the angular distance between the two being about half a degree.

Two New Satellites of Jupiter.—Information has been received (*U.A.I. Circular* 721) of the discovery of two new satellites of Jupiter by Dr. Nicholson on photographs taken with the 100-inch telescope of the Mount Wilson Observatory. Both these satellites (tenth and eleventh in the order of discovery) are reported to be of the 19th magnitude and are extremely faint.

T. P. B.

Blyxa echinosperma.

MESSRS. W. WIGHT AND P. K. BARUA, Indian Tea Association, Tocklai Experimental Station, Cinnamara, Assam, write under date, September 15, 1938, as follows :—

"We wish to draw attention to a phase in the biology of *Blyxa echinosperma* which must be familiar to field workers but which is unrecorded in any relevant literature which we have had the opportunity of consulting. The peduncles of *Blyxa echinosperma* are exceedingly long but the plant appears to inhabit water which is deeper than the maximum length of the peduncle. In deep water the roots somehow release their hold on the bottom so that the plant floats to the top prior to flowering: decay then begins amongst the floating mass of vegetation in which the flowers, with their now unnecessarily long peduncles, develop and set seed with considerable rapidity. In different tanks this phenomenon takes place at slightly different times. In shallow water *Blyxa echinosperma* seems to remain rooted, and the peduncles reach the top of the water, though appreciable decay of the submerged leaves may nevertheless take place. In deep water the rapid rise to the surface of previously submerged plants, complete with root systems, is a striking phenomenon. It would seem that *Blyxa echinsperma* is undesirable in watertanks and we have observed one case where the sudden pollution of a previously clean and sweet tank was caused by the decay of (originally submerged) *Blyxa echinosperma* plants on the surface of the water at the time of anthesis."

RESEARCH ITEMS.

Determination of Finite Groups.—An important contribution to the problem of determination of all finite groups has recently been made by Fitting (*Jahres. bericht. der deut. Math. ver.*, Bd. 48, pp. 77–141). Although the complete and satisfactory solution of the problem is still far from us this contribution makes us realise all possible groups of finite order provided the simple non-abelian groups and their group of automorphisms are known. A summary of the leading steps of his procedure is as follows:

A group is termed semi-simple if it has no normal subgroup which is soluble. If G be any finite group it follows that either it is semi-simple or it will contain a maximum possible normal subgroup N which is soluble. N is, obviously characteristically invariant (*i.e.*, for every autorphism α of G, $N^{\alpha} = N$) and G/N is semi-simple. Hence if one determines all soluble groups N_i and all semi-simple groups S_j, then every finite group can be obtained by extending some N by some S in the sense of the general theory of Schrier. The problem of determining when two such groups are isomorph is also solved here.

Next he comes to the question of determining all finite semi-simple groups. G is termed completely reducible if it is a direct product of simple groups. He shows first of all that G is semi-simple if and only if every factor in its decomposition is non-abelian. He then introduces the groups (n, G) which are formed by the n-dimensional vectors $v_\alpha = (a_1, a_2 \ldots a_n)$ where a's are elements of G and (n, G) is constructed through v_α in such a way that $v_\alpha . v_\beta = v_{\alpha\beta} = (a_1 \beta_1, a_1 \beta_2 \ldots a_n \beta_n)$. The first fundamental theorem is the following: If $E_1, E_2, \ldots$ are all the non-abelian finite groups, then every completely reducible semi-simple group G is constructed as the direct product

$$(n_1,\ E_{s1}) \times (n_2,\ E_{s2}) \times (n_3 \times E_{s3}) \times \ldots$$ where $s_1 < s_2 < s_3 \ldots$ and n_r's run through all positive integers.

He then shows that every semi-simple group G possesses a maximum possible characteristically invariant subgroup which is completely reducible, N say. He also proves the important result that $N = e$. It is clear therefore that G must be obtained by extending N by a suitable factor-group. The Zentralisator Z_N of N in $G = e$. Therefore it follows that every such G must be a subgroup of the group of automorphisms of N. The group A of the automorphisms of N is obviously the direct product of the group of automorphisms of its individual factors which are all simple and non-abelian. Hence if these groups and their groups of automorphisms are known then the problem of obtaining all the semi-simple groups is solved, provided the problem of finding when two of them are isomorph is solved. It is shown by means of a procedure analogous to the proof of the known result that the group of automorphisms of a simple non-abelian group is closed, that two such groups G_1 and G_2 which are subgroups of the group of automorphisms A of the completely-reducible semi-simple group G are isomorph if and only if G_1 and G_2 are conjugate in G.

Next he deals with soluble finite groups. He proves that every such G must itself be nilpotent or it must possess a characteristically invariant maximum possible nilpotent sub-group N and $Z_N = N$. It is known that every finite nilpotent group is the direct product of its sylow sub-groups. Therefore the soluble groups G can also be obtained as the extensions of N.

He gives another method for the Schrier-extension of a group N by the factor group H which possesses a distinct advantage over the older method, *i.e.*, it enables us to find out whether two such groups G and G′ possess an isomorphy which leaves N invariant. In the extensions that are required for his purpose what is wanted is only this, as the normal subgroups considered are all characteristically invariant. The most difficult part of the whole theory consists in finding out all possible factor-systems. The article contains a good extension of Schrier's theory. In particular the problem of determining all possible p-groups is solved partially as the extension of its centre by the corresponding factor-group whose structure is assumed to be known by induction. The extensions in case where the normal subgroup has no element of the centre other than e is considerd. It is also shown as was remarked by R. Baer that the extension problem can be taken to be solved completely provided in the case when N is abelian it is completely solved. K. V. I.

A New Method of Weed Eradication.—Under the title, "Biological eradication of Kans (*Saccharum spontaneum*) in field patches" G. C. Tambe and Y. D. Wad of the Institute of Plant Industry, Indore, Central India, draw attention to what appears to be a simple and efficient method of eradicating troublesome weeds (*Agric. and Livestock in Ind.*, 8, Part IV). The method adopted was to cover, by means of a thick mulch of green material such as sunn hemp, green grass or even green weed growth removed from fields, the patches of land overgrown with the particular weed desired to be destroyed, and allow the mulch to remain through the rainy season. At the end of this period it is found that the decomposing green material had acted on the root system of the weeds under the rotting cover green mantle and had effectively killed it. In addition to such destruction, the treated land is also said to have increased in fertility. Wheat and cotton grown on such treated plots gave significantly higher yields than the controls and in the case of wheat, the quality also greatly improved. The improvement related mainly to the total nitrogen and gluten content which were 2·07 and 11·53 per cent. respectively as against 1·65 and 8·04 per cent. in the control. The treated plots showed a higher content of organic matter in the upper zones of their soils than the

controls and it is surmised that the better quality of the wheat in the treated plots may be due to this increased organic matter content. The essential feature of the method is the use of green material as such in contradiction with dry material like straw or *bhusa* which are found to be ineffective. The method deserves to be tried in the case of other difficult weeds such as the hariali grass (*Cynodon dactylon*) of the black cotton soils, a weed which greatly reduces cotton yields and involves much cost and labour to eradicate and is seldom permanently removed even then. The touch-me-not *Mimosa pudica* is another such weed against which cultural, chemical and other methods are in practice out of the question and a suitable adaptation of this new method deserves a trial. We look forward to the author for a further study of the method on a more extended basis. A. K. Y.

The Relative Values of Organic and Inorganic Nitrogen Fertilisers.—An account of certain manurial experiments for testing the superiority of any of organic nitrogenous fertilisers over inorganic fertilisers supplying the same quantities of nitrogen conducted on the Jealot's Hill Farm of the Imperial Chemical Industries has been abstrated in the *Journal of Agriculture and Livestock in India*, **8**, Part IV. The conclusions are in accordance with the opinions which used to be held until recently when organic nitrogenous manures are being credited with special virtues by reason of their content of organic matter. The experiments were conducted both on the field and in pots and cover two seasons. The crops dealt with were Brussels sprouts, mustard, barley and wheat. By organic nitrogenous manures are meant only those which supply a fairly large quantity of nitrogen entitling them to be called fertilisers and not bulky organic materials with comparatively a low nitrogen content like cattle manure. The results show that organic fertilisers are not superior to inorganic fertilisers in crop-producing power; they have no value beyond what is due to their nitrogen content. Provided the lime status of the soil is maintained at an adequate level inorganic nitrogen fertilisers will give at least as good results as organic fertilisers supplying the same amounts of nitrogen. The slow release of available nitrogen, the humus content of the manure which is held to improve the physical condition of the soil and the presence of a specific beneficial substance such as certain hormones are explained to confer no special advantages on the organic over the inorganic nitrogenous fertilisers. One feels these are far too sweeping conclusions: but even granting their correctness, it is at least doubtful if they will apply to tropical and sub-tropical conditions and furthermore over a more extended period than the two-year period over which these experiments have been carried out. A. K. Y.

Changes in the Testis of the Musk Turtle.—Very little is known about the seasonal changes in the testis of Reptiles, especially of Turtles. P. L. Risley (*Journ. Morph.*, 1938, **63**, No. 2) observes that in the musk turtle (*Sternotherus odoratus*) the spermatogenetic cycle in the testis is limited to the summer months of the year, closely paralleling that of Anura. Spermatogenesis begins in July and is completed in October. The spermatozoa are found in large numbers in the testis from September to May, in the latter month they are all expelled and the germinal epithelium prepares for the spermatogenesis. The spermatogonial divisions are most common in June.

Multiple Chromosomes of *Paratritropodia*.—The chromosomes of most Acrididæ show a remarkable uniformity in number. In males the diploid number is 23 and in females it is 24. The number in *Paratritropodia* as studied by R. L. King and H. W. Beams (*Journ. Morph.*, 1938, **63**, No. 2) is 19 in the male and 20 in the female. The reason for this decrease in number is the association of four pairs of non-homologous chromosomes to form four V-shaped multiples. These multiples result in associations of a higher order than tetrads (hexads and octads) in Metaphase I. But in *P. brunneri* the authors describe, for the first time in Acrididæ, a decad found in the 1st spermatocyte, which is formed by the accessory chromosome associated with an octad.

The Indian Central Jute Committee.*

JUTE is one of the principal cash crops of India. Though its cultivation is restricted to the Eastern Provinces, in 1936–37 it covered an area of 2·886 million acres, which produced a crop of 9·663 million bales. Assuming a price of Rs. 31 per bale, which was the average quotation of the Calcutta market on 9th March 1938, the present-day value of the jute crop raised every year in India amounts to the huge figure of Rs. 30 crores. Out of this crop over 4 million bales are exported each year in the raw state to foreign countries, a nearly equal quantity is first manufactured in the Indian Jute mills and then exported, while about 1·7 million bales of jute goods are consumed within the country.

The figures given above would give one an idea of the gigantic issues involved in the cultivation, transport, marketing, manufacture and storage of Indian jute. These issues create numerous intricate problems, some of a biological, others technical, yet others of an economic nature. Hitherto these problems have either been ignored or have been tackled in an isolated and scattered way without any systematic plan or efficient

* The Indian Central Jute Committee.—*First Annual Report*, for the period 1st December 1936–31st March 1938. Pp. 60.

collaboration between the various interests concerned in the production and manufacture of jute.

The Royal Commission on Agriculture after reviewing the situation and pointing out the defects in the existing system, or rather lack of it, recommended in 1928 the establishment of an Indian Central Jute Committee, somewhat on the lines of the Indian Central Cotton Committee, which, functioning successfully since 1920, had been mainly responsible for effecting an appreciable improvement in the quality and marketing of the Indian cotton crop. Some years elapsed before this wise recommendation of the Royal Commission on Agriculture was translated into action: the Indian Central Jute Committee was actually set up by a resolution of the Government of India dated the 28th May 1936. It has now issued its first *Annual Report* covering the period from 1st December 1936 to 31st March 1938.

This *Report*, which makes interesting reading, gives a lucid account of the manifold problems relating to the cultivation, marketing and manufacture of jute which the Committee have set before itself and the way it proposes to tackle them. On the cultivation side it has set up a small laboratory at a capital cost of Rs. 45,000 and a recurring cost of over Rs. 40,000 per annum. This laboratory situated at the Government Farm, Dacca, will study the botanical, physiological and entomological problems of jute cultivation with a view to evolving improved varieties which will be given out to the cultivators. For the supply of seed of these varieties the Committee has set aside Rs. 50,000.

For a commodity like jute, which is grown to be spun, the work in the fields and the agricultural research laboratory would remain incomplete and inconclusive if it were not supplemented by technological tests made, under standard and reproducible conditions, with the object of finding out the relative merits of the improved varieties. The Jute Committee like the Cotton Committee has recognised the supreme necessity of these technological tests and has set up a Technological Laboratory at Calcutta at a capital cost of Rs. 3,80,000 and with an estimated recurring cost of Rs. 1,80,000 for the first three years. The main function of this Laboratory, which will be equipped with a spinning mill, a conditioning plant for maintaining constant humidity and temperature in the spinning and testing rooms and a wide range of testing instruments, will be in the beginning, to test the improved varieties and to compare them among themselves and with the local varieties. Later on, when the technique of the routine tests becomes more or less established, it is expected that it will be in a position to undertake technological work on the manufacture of jute goods. When this development takes place, it is hoped that it would be possible to establish a closer *liaison*, preferably an amalgamation, with the Research Department of the Indian Jute Mills Association, as it would be undesirable and costly, in the same city, to duplicate work directed towards the same end, namely, the improvement of Indian jute and its best utilisation in the manufacturing processes.

The Committee's activities, described above, principally concern the cultivator. The Committee, however, has not wisely neglected the interests of another important class, namely, the merchants, for whose benefit it proposes to spend about Rs. 62,000 per annum on improvement of jute forecasts, Rs. 10,000 per annum on collection of statistics and dissemination of information and Rs. 30,000 on an inquiry into the marketing and transport of jute and its products.

For all these various items of expenditure the Government of India have agreed to make a yearly grant-in-aid of Rs. 5 lakhs, for five years. The work of the Committee is bound to grow, and those who are benefited by its various activities will ask for more and more problems to be undertaken by it. At the end of these five years, therefore, the Government will be faced with the necessity of either increasing the amount of the grant-in-aid or making the Committee self-supporting by levying a suitable cess on jute.

The Committee, as constituted, is a thoroughly representative body including among its members growers, merchants, spinners, administrators and experts. This feature is one of the chief sources of strength of such Committees, as the representatives of the various bodies can put forward the lines of work in which they are keenly interested and the full Committee can adopt a comprehensive view. One, however, feels that the Committee, so many of whose activities are of a scientific nature, would be strengthened by the inclusion of one or two scientists.

The success of such Committees depends to a large extent upon the first administrative officer, upon whom falls the difficult task of organising the department, laying down healthy traditions, chalking out the initial programme of work and equipping the laboratories. Judging from the manner in which the problems facing the jute industry have been analysed and set forth and the way in which the programme of future work has been drawn up, we feel that the Committee has been very fortunate in starting its career under the chairmanship of Sir Bryce Burt, who has a long and distinguished record of association with the work of such Committees and in securing the services of Mr. A. P. Cliff as its first Secretary. We feel confident that these two gentlemen will direct the Committee's activities in the right direction and we wish it a long period of useful service.

N. A.

SCIENCE NOTES.

Effect of Light Treatment on Seed Potatoes.—Mr. D. N. Sen Gupta, B.Ag., writes under date September 1, 1938:—"The beneficial effect of daylight to potatoes during the storage period has long been recognized in potato growing countries in the West. A simple experiment was carried out at Jorhat for two successive seasons of 1935 and 1936 on this line. Vernalisation of potato has been recommended by the Russian worker, Dr. Lyssenko. 120 lbs. of Darjeeling seed potatoes were used, in our experiment; one half of the quantity was stored in sand in an ordinary godown for control, and the other half was spread in a single layer and was subjected to constant illumination from close quarters under 100 c.p. light. From time to time the tubers were turned over.

In the first year electric light was used while in the second year a 100 c.p. petromax supplied the necessary illumination. The treatment continued for 28 days in each of the seasons starting on the 18th and the 27th October repsectively. The observed difference in the general vigour of the standing crops under the two treatments fairly agreed with the actual finding at harvest. The first year's crop, vernalized under the electric light, gave the best result while the second year's crop vernalized by the petromax did not respond so well.

The results of two years' work have definitely shown that exposing potatoes to light continually for 25–28 days gives about 50% more yield although the cost of such a treatment is negligibly small in comparison to the yield obtained."

* * *

Ancient Culture in the Indus Valley.—Discoveries throwing new light on the problem of the successive cultures that flourished in the Indus Valley in the 3rd millennium B.C. have been made. Overlying the main cultural stratum contemporaneous with Mohenjodaro, there have been found two later ones, which appear to belong to a people unconnected with the earlier civilization.

This interesting information is given in the latest *Annual Report* of the Archæological Survey of India for the year 1935–36, which records the arrival during the year of the expedition of the American School of Iranian and Indic Studies. Dr. E. J. H. Mackay, formerly of the Archæological Survey, was the Field Director of the expedition.

Chanhu-daro in the Nawabshah District of Sind was the site selected for excavation by the expedition. That during the Mohenjodaro period Chanhu-daro was an important industrial town, specializing in the manufacture of beads and toys, is one of the conclusions reached as a result of the excavations made. Discoveries have also been made, which show not merely what the finished articles were, but also the successive stages of making beads out of fresh agate nodules.

The departmental programme of excavation was fairly well spread over Northern India within the limited funds available. In Sind two sites in the Khairpur State, *viz.*, Dijijitakri and Kotasur, have been explored. The 40 feet high mound at the former place has revealed five strata illustrating the earlier and later stages of the Indus Valley culture, and also at Kotasur, pottery of late prehistoric period with interesting painted designs, both geometrical and animal, has been brought to light.

At Taxila, the north-west portion of the monastery attached to the Dharamarajika stupa, was exposed, completing the lay-out of the monastic complex. A hoard has been found of 500 coins, mostly of Vasudeva, the Kushan king, which fixes the date of the monastery as the 3rd century A.D. Images of some Brahmanical deities, such as Vishnu and Kartikeya, have also been found at the place. The find of these Brahmanical images, in the Buddhist establishments of Taxila before their destruction at the hands of the Hun hordes, it is said, exemplifies once more the eclectic tendency of the Gupta Empire.

Fresh excavations in Bihar have brought to light two more monasteries at Nalanda, and some interesting early relics of Naga worship at the Maniyar Math at Rajgir. At Lauriya Nandangarh, in the district of Champaran, excavations were conducted in several mounds with a view to examine the character of the remains. These remains, according to conclusions reached, appear to be of several Buddhist stupas, some of which date back to as early as the 4th century B.C. At Nandangarh, in a mound 82 feet high, discovery has been made of a basement wall of a colossal structure with a number of re-entrant angles.

In Bengal an interesting monument consisting of 170 chambers of shafts, which present a curious honey-combed appearance, has been unearthed at the Medh mound near Gokul in the Bhogra District. The monuments here are nearly 1300 years old, being of the 6th or 7th century A.D. and, according to archæologists, appear to have been within the suburbs of the city of Mahasthan.

Other discoveries made during the year include a number of sites consisting of burial chambers in rock or pottery vases and urns in Malabar, Tinnevelly, Coimbatore, North Arcot and Cuddappah Districts in Madras, and an old brick monastery, close to the Somingyi pagoda at Myinpagan in Burma.

In Jaipur a unique circular Buddhist temple of the 3rd century B.C. and a large monastery, which continued to be occupied up to the 1st century A.D. have been brought to light by the local Director of Archæological Survey.

The most important discovery of the year in epigraphy, it is said, is that of four-stone pillars at Badva, in the Kotah State of Rajputana, recording the performance of a sacrifice by three sons of a Mokhari General all dated in 295 Vikrama era, equivalent to 238 A.D.

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With the object of finding out additional outlets for Indian short staple cottons, the **Indian Central Cotton Committee** has set aside a sum of Rs. 30,000 to explore the possibilities of manufacturing rayon from short staple cotton, particularly from cotton linters and similar materials. The Industrial Research Bureau is collaborating

with the Committee in these enquiries and in working out the relative costs and the suitability of the various processes for the manufacture of artificial silk in India. The data so far available indicate that the price of chemical cotton manufactured from short staple cotton would be far too high, but there is a possibility that chemical cotton produced from linters would be reasonably cheap. It is now proposed to carry the experimental work done in the past for the determination of the cost of producing chemical cotton, a stage further by the installation of a small-scale pilot plant for determining the cost of preparing chemical cotton which is the basis for rayon manufacture.

* * *

The Periodical 'Failures' of Cotton Crops in the Punjab.—Through the kind courtesy of the Secretary, Indian Central Cotton Committee, we have received certain extracts from Dr. Mason's inspection report on the scheme of periodical 'failure' of cotton crops in the Punjab. The Punjab American Cotton Industry is still young. It was not till 1905, that American seed was imported from Darwa and selection begun. All the major crop ' failures ' occurred between 1919-1928. There has been no major ' failure ' since, though ' partial failures ' occurred in 1931 and 1932. Similar ' failures ' occur in Sudan and the cause of the Sudan 'failure' is not yet known.

The Punjab American Cotton Industry, appears to be approaching a condition of equilibrium. There are two reasons for this; the plants get acclimatised the longer they are cultivated and the grower learns by experience the cultural requirements of the crop.

From an examination of all relevant facts relating to the ' failures ' Dr. Mason considers it probable that the ' failures ' occurred as a result of interaction of at least two factors: " We may postulate first of all a soil factor, probably high content of alkali salts, which may persist for more than a single year. In the presence of this factor any climatic or insect (*e.g.*, white fly) factor detrimental to growth may result in crop ' failure '. It is noteworthy that the ' failure ' years appear to have been years of high July-August rainfall, but that high rainfall at this time of year has not always been accompanied by a ' failure '. The Sandwiching of ' partial failures ' between ' full failures ' may be explained by assuming that the climatic factors have been relatively favourable for growth, even though the alkali content of the soil may have been high. It will be clear that soil alkali may adversely affect the activity of the nitrogen bacteria.

" To sum up it is suggested that periods of 2-3 years have occurred during which the salt content of the soil has remained high and that this has rendered the plant susceptible both to Tirak and to nutritional bad opening of the boll. It is further suggested that when a year in which the climate is detrimental to growth has synchronised with one of these periods of high soil salt content, a ' failure ' has occurred. It is not improbable that in the past there has been some confusion between Tirak and nutritional bad opening."

* * *

Flying Training in India.—The introduction of the Empire Air Mail Scheme, the provision of night flying facilities and the grant of large subsidies to the flying clubs by the Government of India have resulted in a substantial increase in the number of hours flown and the number of ' A ' pilots trained.

The three-year agreement which the Government of India has with the subsidised flying clubs, expires at the end of the current year.

The total amount of the subsidy grant distributed among the seven clubs was Rs. 1,43,128 in 1936-37, and Rs. 1,36,500 in 1937-38. The increased flying done by the clubs has been devoted principally to the training of commercial pilots, although the clubs do not earn Government bonuses in respect of such training.

The number of commercial pilots trained for the past 3 years, 1935, 1936 and 1937, are respectively 9, 18 and 20.

Introduction of the Empire Air Mail Scheme early in 1938, has been responsible for a substantial increase in the number of persons actively employed in civil flying in India. The total number employed by the aircraft operating companies operating wholly in India, was 115 as on 31-12-1936 and 269 as on 31-7-1938.

One of the difficulties with which the operating companies were faced was in providing the advanced training which is necessary before a pilot, who has been wholly trained on the light types of aircraft such as are owned by the flying clubs, can be given charge of a larger type of commercial machine which has a higher performance. The Government of India gave assistance by arranging special flying courses on their Avro-X aeroplanes, and Tatas established, at their own cost, in addition what virtually amounted to an advanced flying training school. They also undertook the further training of wireless operators, whom they recruited from those candidates who had passed the wireless course at the *Aeronautical Training Centre of India.*

While the flying clubs provide the necessary regional centres for initial training, the need has been felt for an advanced aviation school.

If there is not to be retrogression, it would seem that the flying clubs in India will have to be given a fresh *raison d'etre* as well as a new subsidy agreement at the end of the year.

* * *

Deterioration of Structures in Sea-Water.—A Committee of the Institution of Civil Engineers has been studying the problem of the deterioration and protection of structures in sea-water since 1916. Reports have been issued at approximately yearly intervals, the recent Report (H. M. Stationery Office, London, 1938) being the 17th of the series. Reports are given on the condition of timber specimens subjected to protective treatment and exposed to sea-action in various parts of the world. Results are given of a research into the deterioration of reinforced concrete. The present report is of particular interest in that it contains the complete sets of figures for the corrosion of iron and steel bars exposed in various Ports for periods of 5, 10 and 15 years, this research being now concluded.

On August 2nd, **Jean Baptiste Perrin** one of the leading physicists of the world, announced to the *French Academy of Sciences*, the discovery by his collaborators of what he believed to be the ninety-third chemical element. Perrin, who is President of the Academy, reported that the new substance is heavier than uranium, which up to this time has been known as the heaviest of all substances. Many physicists have limited the number of possible elements to ninety-two on the assumption that any substance heavier than uranium would not be stable enough to hold together. Perrin, however, announces that his new discovery would be in natural and stable form, and could be produced in definite quantities (*Sky*, 1938, **2**, No. 11, 13).

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University of Bombay.—

Dr. K. Venkataraman, D.Sc., Ph.D. (Manchester), F.I.C., has been appointed Mody Professor and Head of the Department of Chemical Technology in the University of Bombay to succeed Professor R. B. Forster, D.Sc. (N.U.I.), Ph.D. (Berlin), F.I.C.

Dr. T. S. Wheeler, Principal, has been granted leave preparatory to retirement. He will sail for England on the 22nd inst. to join next year the post of State Chemist to the Government of Eire.

Presiding over the students' function in honour of Dr. Wheeler, Mr. V. N. Chandavarkar, the Vice-Chancellor, paid tribute to Dr. Wheeler for his work in the University and in the Institute for the cause of science. He referred to him as an administrator known for his strict discipline and impartial decisions.

The University of Bombay has conferred the Degree of Doctor of Science on Mr. N. C. Chatterji, Entomologist, Forest Research Institute, Dehra Dun.

* * *

Calcutta University.—The degree of Doctor of Science has been awarded to **Mr. Ranjit Ghose, M.Sc.**, in consideration of his thesis dealing with (1) the synthesis of Jaborandi Alkaloids, (2) studies in phenanthrene and (3) a new synthesis of carmic acids.

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We have pleasure in announcing that **Dr. M. B. Mirza, D.Sc.**, Director, Zoological Laboratories, Muslim University, Aligarh, has accepted our invitation to join the Board of Editorial Co-operation.

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Announcements.

Indian Academy of Sciences.—It has been decided to hold the *Fourth Annual Meeting of the Academy*, at Madras, between the 19th and 24th December 1938. The exact date or dates of the meeting will be communicated to Fellows in due course.

Papers intended for presentation at the Scientific Meeting during the annual session may kindly be sent in to the Secretary, Indian Academy of Sciences, Hebbal P.O., Bangalore, at an early date.

The Entomological Society of India.—The first annual general meeting of the Entomological Society of India will be held in Lahore in the first week of January 1939. Intimation of the exact date, time and place of the meeting will be communicated to members later. In the meantime the following may be sent to the Secretary at the Imperial Agricultural Research Institute, New Delhi, by the end of October 1938:—

(i) Abstracts of papers which any member may desire to read and also an indication of the nature of the exhibit to be shown and a very short summary of the remarks to be made thereon.

(ii) Proposals, if any, for the amendment of the existing rules of the Society, a copy of which may be obtained from the Secretary.

(iii) Notice of any discussion that any member may propose to initiate relating to the scientific or non-scientific business of the Society.

Only members who have at least paid their admission fee to the Society in the year 1938, will be eligible to vote and take part in the non-scientific business of the Society.

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We acknowledge with thanks, receipt of the following:—

"Agricultural Gazette of New South Wales," Vol. 49, No. 9.

"Journal of Agricultural Research," Vol. 56, Nos. 2 and 3.

"Indian Journal of Agricultural Science," Vol. 8, No. 4.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 29, No. 8.

"The Philippine Agriculturist," Vol. 27, No. 4.

"Allahabad Farmer," Vol. 12, No. 4.

"Journal of the Royal Society of Arts," Vol. 86, Nos. 4475–78.

"Biochemical Journal," Vol. 32, No. 8.

"Journal of the Indian Botanical Society," Vol. 27, No. 4.

"Journal of the Institute of Brewing," Vol. 44, No. 8.

"Chemical Age," Vol. 39, Nos. 1000–1003.

"Journal of Chemical Physics," Vol. 6, No. 9.

"Journal of the Indian Chemical Society," Vol. 15, Nos. 7 and 8.

"Berichte der Deutschen chemischen gesselschaft," Vol. 71, Nos. 8-9.

"Journal de chemie physique," Vol. 35, No. 7.

"Transactions of the Faraday Society," Vol. 34, No. 209.

"Indian Forester," Vol. 44, No. 10.

"Indian Forest Records," Vol. 3, No. 3.

"Forschungen und Fortschritte," Vol. 14, Nos. 25-27.

"Genetics," Vol. 23, No. 5.

"Journal of the Mining and Metallurgical Institute of India," Vol. 34, No. 2.

"Bulletin of the American Meteorological Society," Vol. 19, No. 6.

"Journal of the Indian Mathematical Society", Vol. 3, No. 3.

Catalogues.

Messrs. Cambridge University Press, London, "Autumn Books".

Messrs. Edward Arnold & Co., New Books, Autumn 1938.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

September 1938. SECTION A.—(Miss) Ione Nitravati Dharam Dass and Sikhibhushan Dutt: *Colour in Relation to Chemical Constitution of the Organic and Inorganic Salts of* Iso-*nitro-diphenyl-thio-Barbituric Acid and its Higher Homologues and Analogues.*—The orange coloured acid, on treatment with alkalis or organic bases, changes into intense blue and green coloured salts. This is shown to be due to a fundamental change in the constitution of the molecule from an oximino-ketonic to a nitroso-enolic structure. Inder Chowla: *A Theorem in the Additive Theory of Numbers.* R. Vaidyanathaswamy: *Quasi-boolean Algebras and Many Valued Logics.* V. D. Majumdar and M. B. Vajifdar: *Coefficient of Viscosity of Air.*—Using a modified form of Wagstaff's apparatus for measuring by the method of interference fringes, η_{23}° C has been determined as $(1834 \cdot 38 \pm 0 \cdot 35) \times 10^{-7}$ *c.g.s.* units. A. Narasinga Rao: *Studies in Turbine Geometry.—II. On the Sub-Geometries of Lie which belong to the Mobius-Laguerre Pencil.*

September 1938. SECTION B.—M. S. Randhawa: *Observations on Some Zygnemales from Northern India—Part I.* G. N. Rangaswami Ayyangar, V. Panduranga Rao and D. S. Rajabhooshanam: *Sorghum-Size Relationships of Seed Embryo, Seedling and the First Seedling Leaves.* C. Bhashyakarla Rao: *The Myxophyceæ of the Orissa Province, India—I.* A. Ramakrishna Reddy: *The Cytology of Digestion and Absorption in the Crab* Paratelphusa (Oziotelphusa) hydrodromus (*Herbst*). L. P. Mathur and Munshi Lal Sharma: *Observations on the Abnormalities in the Common Indian Frog,* Rana tigrina *Daud.* Jai Chand Luthra, Abdus Sattar and Sardul Singh: *Occurrence of Stem Canker Disease of Sugarcane* (Cytospora sacchari *Butyl*). *in the Punjab.* P. N. Mehra: *Apogamy in* Adiantum lunulatum *Burm., Part I. (Morphological).* P. N. Mehra: *Apogamy in* Pteris biaurita *Linn.* P. N. Mehra: *Some Abnormalities in the Female Strobilus of* Ginkgo biloba *L.* P. N. Mehra: *The Germination of Pollen Grains in Artificial Cultures in* Ephedra foliata *Boiss and* Ephedra gerardiana *Wall.* B. L. Bhatia and S. B. Setna: *On Some Gregarine Parasites from Certian Polychete Worms from the Andaman Islands.* V. Ranganathan and B. N. Sastri: *Procedure for Determining the Nature of the Degradation Products during Proteolysis.*

National Academy of Sciences:

June 1938.—Satya Prakash and Sikhibhushan Dutt: *Colour and Chemical Constitution. The Organic and Inorganic Salts of Diphenylvioluric Acid.* V. S. Dubey, Y. P. Varshney and R. S. Sharma: *Caustic Soda and Alumina from Salt and Bauxite.* Mahadeo Prasad Gupta and Shikhibhushan Dutt: *Chemical Examination of* Indigofera linifolia *Retz. The Isolation of its Active Principle.* J. Dayal: *Studies on the Trematode Parasites of Fishes.—A New Trematode* Nixamia hyderabadi *N. Gen., N. Sp., from the Intestine of a freshwater fish,* Ophiocephalus punctatus.

August 25, 1938.—Shah Muhammad Sulaiman: *The Mathematical Theory of a New Relativity (Generalised Gravitation).* A. C. Banerji and P. L. Bhatnagar: *The Solution of Certain Types of Differential Equations.* R. D. Vidyarthi: *New Avian Trematodes (Family Diplostomidæ) from Indian Birds.* Gauri Shankar Basu and S. B. Dutt: *Tungsten and Molybdenum Powder in Organic Synthesis.* S. B. Dutt: *Chemical Examination of Indian Molasses: Fusel Oil from the Patent Still Distillery of Messrs. Carew & Co., at Rosa, Shahjehanpur.* Anil Chandra Chatterji and Shikhibhushan Dutt: *Cadmium Powder as a Synthetic Reagent.* Binayendra Nath Sen: *The Formation of Liesegang Rings in the Presence of Precipitates.* R. C. Chatterji: *Annotated List of the Helminths recorded from Domesticated Animals of Burma, Part I. Trematoda.* B. N. Singh and M. L. Mehta: *Changes in Respiration and H-ion Concentration in Wounded Potato Tubers.*

Indian Association for the Cultivation of Science: (*Proceedings, Volume 21, Part IV.*)

August 1938.—Jagannath Gupta: *Hexa-co-ordination in Telluric Acid and in Molybdates and Tungstates in Solution.* Bibha Majumdar: *The Theory of Absorption in Ionised Gas. I. Opacity in Stellar Material. II. Optical Properties of liquid metals.* K. Banerjee and Rajiuddin Ahmed: *Structure of Aromatic Compounds. Part IV. Space Group and Atomic Arrangements in Phloroglucine Dihydrate.* Krishnapada Ghosh and Bonbehari Ghosh: *On the Electric Conduction due to 4 Electrons in some Trivalent Rare Earth Compounds.* S. K. Mukerji and Abdul Aziz: *On the Raman Spectrum of Diphenyl.* G. R. Paranjpe and D. J. Davar: *Dielectric Properties of Some Organic Substances.* S. R. Khastgir and M. K. Chakravarty: *The Attenuation of Ultra-Short Radio Waves along with Earth.*

Indian Physical Society:

August 27, 1938.—Mrs. B. Majumdar: *Theory of Absorption in Ionised Gases—Part II. Optical Properties of Liquid Metals.* P. Koteswaram: *Dissociation in Sulphuric Acid with Temperature.* K. Banerji and R. Ahmed: *Structure of Aromatic compounds. IV. Space Groups and Atomic Arrangements in Phloro-glucine Dihydrate.* P. Ghosh and B. B. Ghosh: *On the Electronic Conduction due to '4 f' Electrons in Some Trivalent Rare Earth compounds.* S. Basu and A. T. Maitra: *Thermal Coefficient of Rock-Salt by X-ray Reflection.*

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Indian Chemical Society:

July 1938.—Priyadaranjan Ray and Nripendra Nath Ghosh: *Complex Compounds of Biguanide with Tervalent Metals. Part II. Chromium Biguanidines.* Priyadaranjan Ray and Nripendra Nath Ghosh: *Complex Compounds*

of Biguanide with Tervalent Metals. Part III. Chromium Phenylbiguanidines. PRIYADARANJAN RAY AND HARIBOLA SAHA : *Complex Compounds of Biguanide with Tervalent Metals. Part IV. Chromium* bis-*Biguanidines.* SISIR KUMAR GUHA : *Studies in Indigoid Dyes. Part III.* MATA PRASAD, S. M. MEHTA AND MISS H. RATHNAMMA : *Studies in Thixotropic Gelation of Thorium Molybdate gels.* SHRIDHAR SARVOTTAM JOSHI AND T. V. SUBBA RAO : *Electrodeposition of Lead on Base Metals. Part I. Behaviour of Alkaline Baths with Iron Cathodes at Low Current Densities.* S. M. SETHNA AND R. C. SHAH : *Pechmann Condensation of Methyl β-Resorcylate with Ethyl α-Alkylacetoacetates.* M. K. MADHURANATH AND B. L. MANJUNATH : *Chemical Examination of the Oil from the Seeds of* Santalum album (*Linn.*). KARTAR S. NARANG, JNANENDRA NATH RAY AND BHARPUR SINGH ROY : *Rottlerin, Part II.* S. CHATTERJEE, M. SANYAL AND M. GOSWAMI : *Studies in Catalytic Dehydration.* MAHAN SINGH : *Dimethylamino and Diethylaminophenyliminocamphors. Reagents for Mercury.*

August 1938.—K. GANAPATHI : *The Chemistry of Some Derivatives of Decalin, Part I.* BALWANT SINGH AND G. AHMAD : *Potentiometric Studies in Diazotisation. Determination of Aromatic Amides.* MR. RAMART, K. G. NAIK AND C. M. MEHTA : *Relation between Chemical Activity and Absorption in the Ultra-Violet of Certain Organic Molecules : Part I.—Study of the Absorption Spectra of the Chloro Derivatives of the Substituted Amides of Malonic Acid.* K. G. NAIK, R. K. TRIVEDI AND C. M. MEHTA : *Relations between Chemical Activity and Absorption in the Ultra-Violet of Certain Organic Molecules : Part II. Velocity of Saponification of the Chloro Derivatives of the Substituted Amides of Malonic Acid.* S. CHATTERJEE, A. SHAH AND M. GOSWAMI : *Composition of Boiled Oil.* BAIDYANATH GHOSH AND B. C. GUHA : *Vitamin C and Toxins : Part I—The Effect of Vitamin C and other Reducing Substances on Diphtheria and Tetanus Toxins* in vitro. BAIDYANATH GHOSH AND B. C. GUHA : *Vitamin C and Toxins : Part II.—The Effect of the Administration of Vitamin C to Guinea pigs Injected with Diphtheria and Tetanus Toxins.* BAIDYANATH GHOSH : *Observations on the Relation between Pregnancy, Sex-harmones and the Vitamin C Content of the Tissues of Guinea-pigs.* S. K. MITRA : *Experiments on the Synthesis of Cytisine : Part I. Synthesis of* 3 : 5 *Dicarbethoxypyrone-6-acetate and the corresponding Pyridones.* MUHAMMAD QUDRAT-i-KHUDA, ASHUTOSH MUKHERJI AND PHANIBHUSHAN BANERJI (in part) : *Strainless Monocyclic Rings. Part II.—Synthesis of* 3-*Methyl-cyclohexane-1-carboxyl-1-acetic acid and Sepration of its Isomers.* G. P. PENDSE AND JAGRAJ BEHARI LAL : *Constitutents of the Seeds of* Blepharis edulis *Pers. The Composition of the Oil. A Correction Note.*

Indian Botanical Society:

September 1938.—BOERGESEN, F. : *Contributions to a South Indian Marine Algal Flora—III.* KAJALE, L. B. : *Embryo and Seed Development in the Nyctaginaceæ.—I. Studies in the Genus* Boehaavia. DASTUR, R. H., AND WINIFRED JOHN: *The Growth of Rice Seedlings in Salt Solutions of Different H-ion Concentrations.* SCHMID, E. : *Contributions to the Knowledge of Flora and Vegetation in the Central Himalayas.*

The Entomological Society of India:
(New Delhi Branch.)

July 26, 1938.—E. S. NARAYANAN : *Biology of Two Indian Species of* Apanteles (*Braconidiæ*) *of Economic Importance.* L. N. NIGAM : *Life-History of the* ak *Grasshopper,* Pœcilocerus pictus.

The following exhibits were shown and commented upon : Three species of termites swarming in Delhi early in the rainy season (H. S. Pruthi) ; *Mylloceru*s Prox *lactivirens* Marshall, damaging cotton at Delhi ; *Anomala lineatipennis* damaging apple fruits in Simla ; Egg clusters, pupæ and adults of *Epistictia viridimaculata* Boh. from leaves of *Steriospermum suaveolens* in Dehra Dun and grubs of *Podontia* 14-*punctata* (?) infesting *Dualianga sonnertoides* in Dehra Dun (T. Ahmad) ; A nest of the red-ant, *Oecophylla smaragdina* F., from Karnal (Ghulam Ullah) ; *Chilomenes sexmaculata* F. (Coccinellidæ) showing colour variations (A. P. Kapur) ; Nest of the spider *Stegodyphus sarasinorum* Karsch, and some of its fauna from Dehra Dun (K. B. Lal).

A resolution deeply regretting the death of Dr. Geza de Horvath of Budapest, one of the founders of the modern classification of Hemiptera, was passed unanimously.

Meteorological Office Colloquium, Poona:

August 31, 1938.—RAO BAHADUR Y. RAMACHANDRA RAO, Locust Research Entomologist, Karachi, on "*The Locust Problem in India*".